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(54) **IMAGING ELEMENT AND ELECTRONIC APPARATUS**

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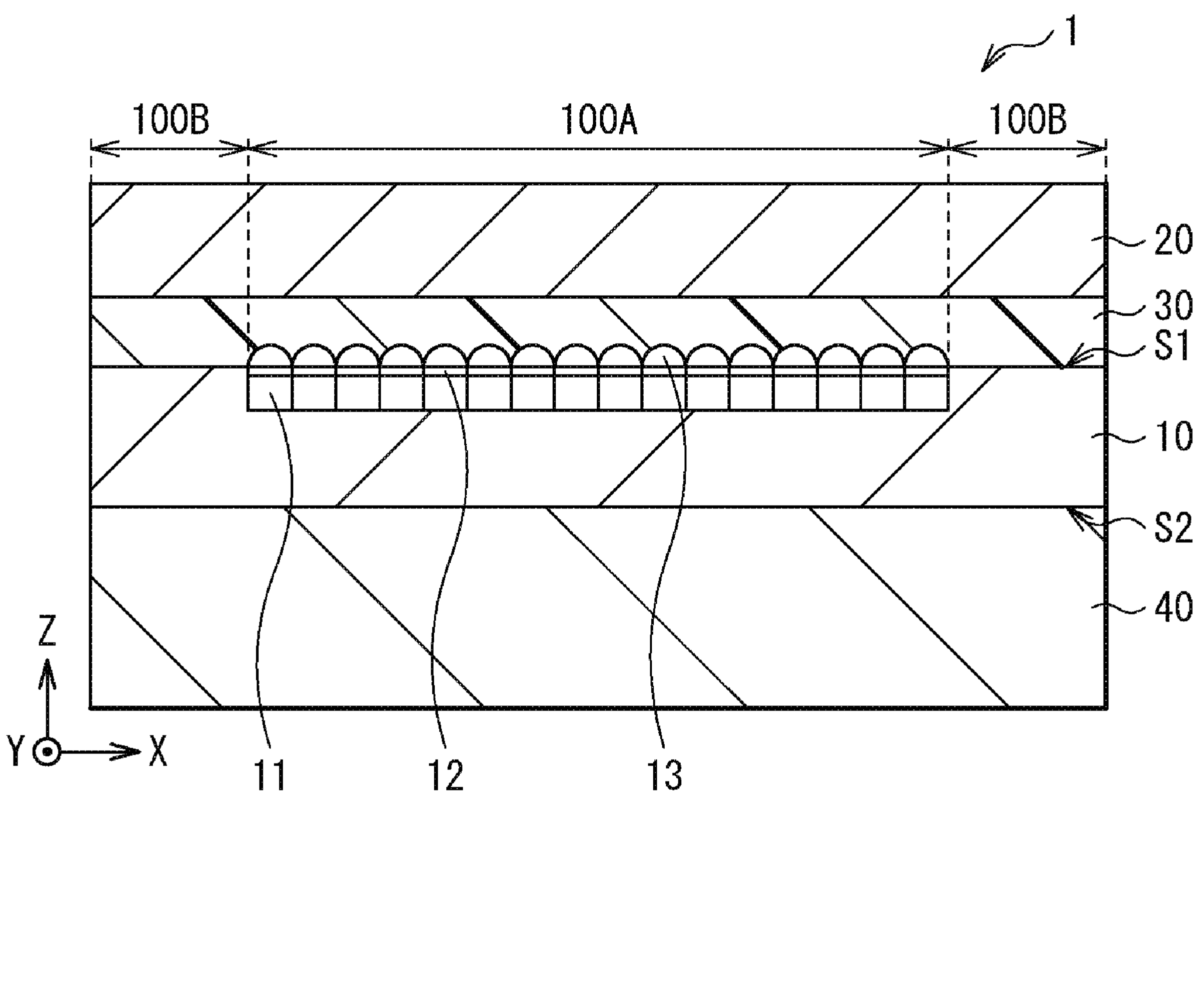
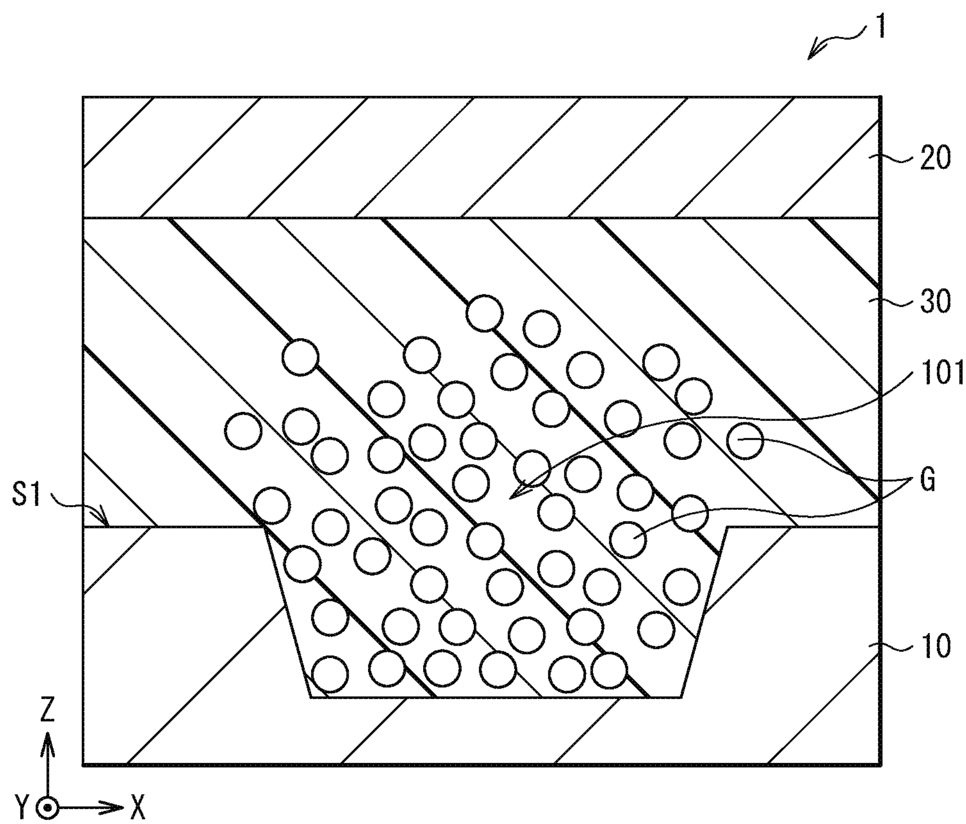
(57) **ABSTRACT**

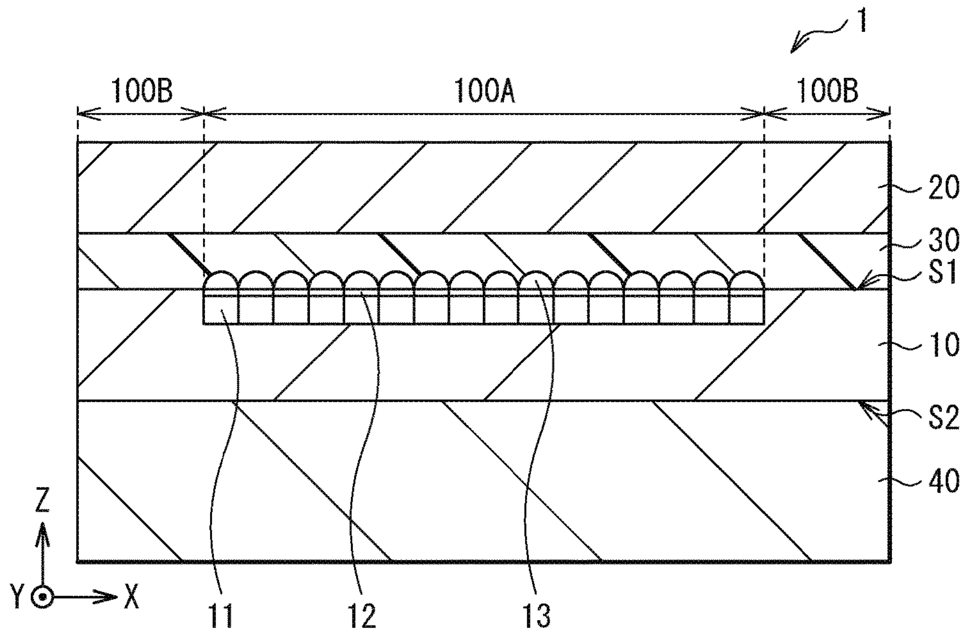
An imaging element according to an embodiment of the present disclosure includes: a sensor substrate having a light-receiving region in which a plurality of light-receiving elements are arranged and a peripheral region provided around the light-receiving region; a sealing member disposed to be opposed to one surface of the sensor substrate; a resin layer that attaches the sensor substrate and the sealing member to each other; and an excavated part provided in the peripheral region of the one surface of the sensor substrate, and in which the resin layer is embedded, with the resin layer having one or a plurality of gaps inside the excavated part in a plan view.



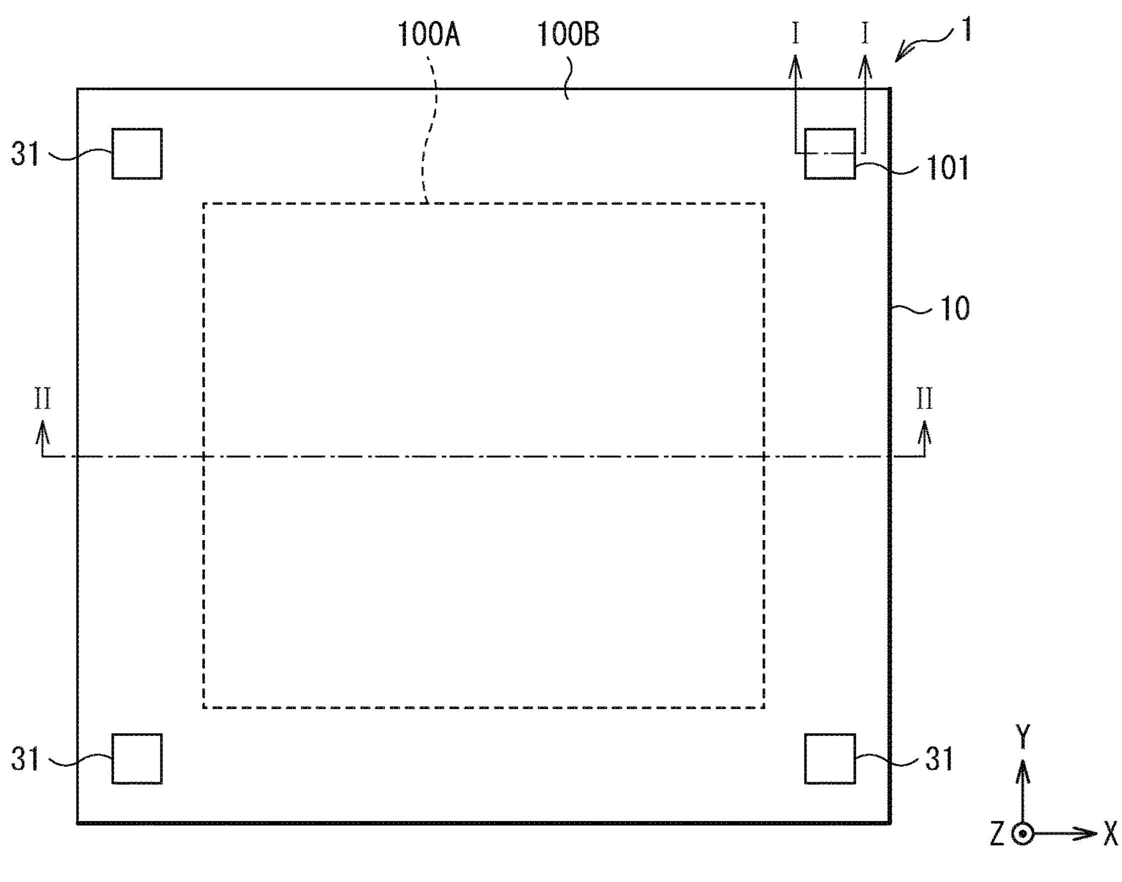
[FIG. 1]



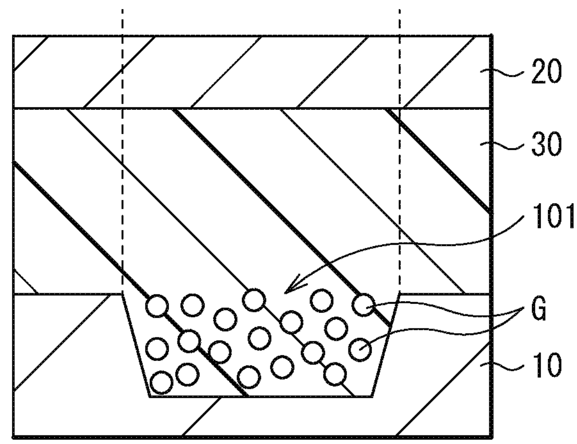
[FIG. 2]


1
100B
100A
100B
20
30
S1
10
S2
40
Z
Y
X
11
12
13

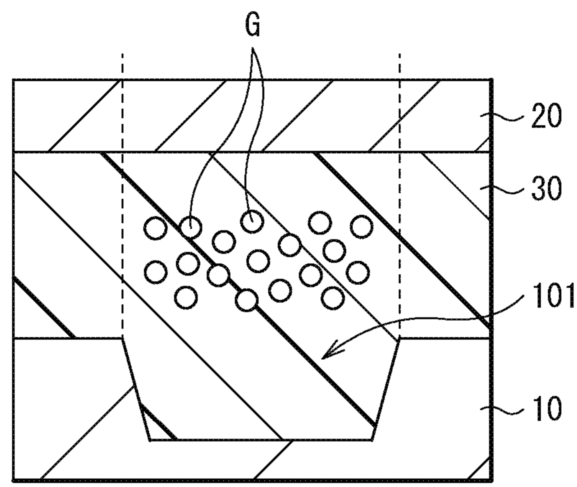
[FIG. 3]


100A
100B
I
I
1
31
101
10
II
II
31
31
Y
Z
X

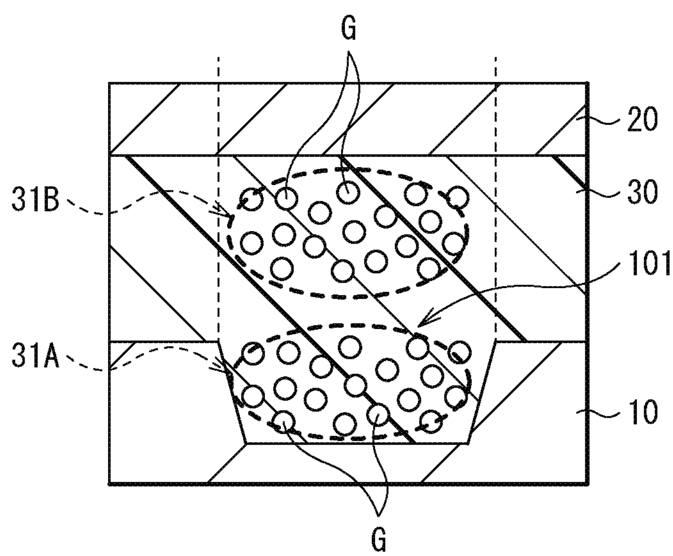
[FIG. 4A]



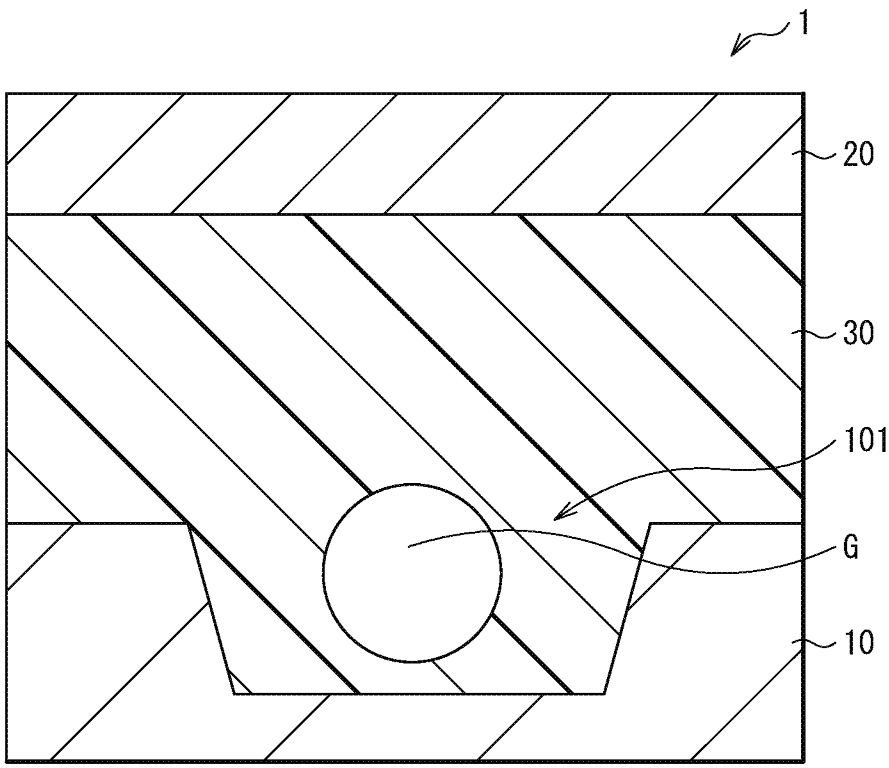
[FIG. 4B]



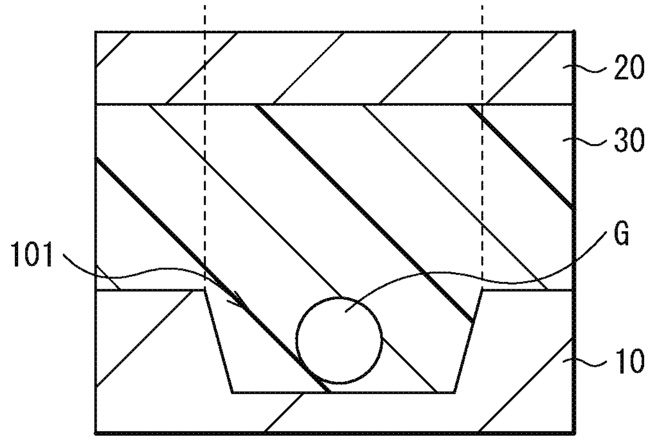
[FIG. 4C]



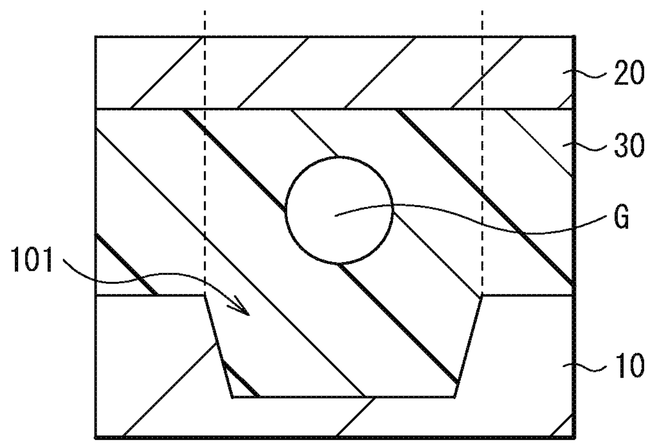
[FIG. 5]



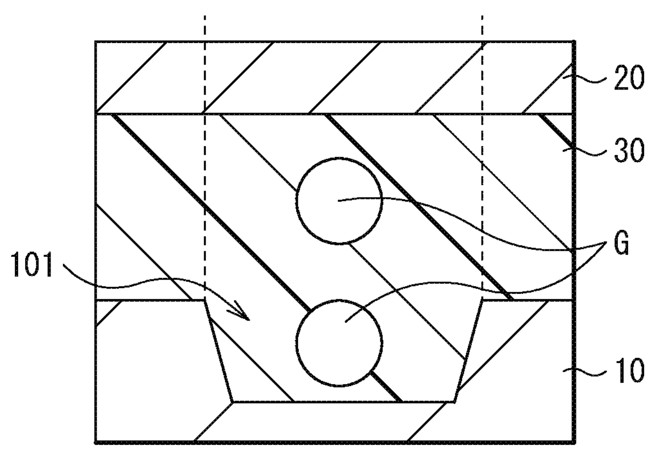
[FIG. 6A]



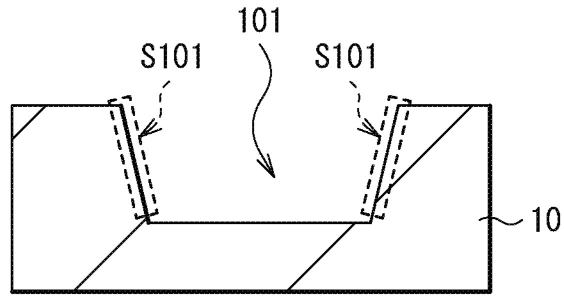
[FIG. 6B]



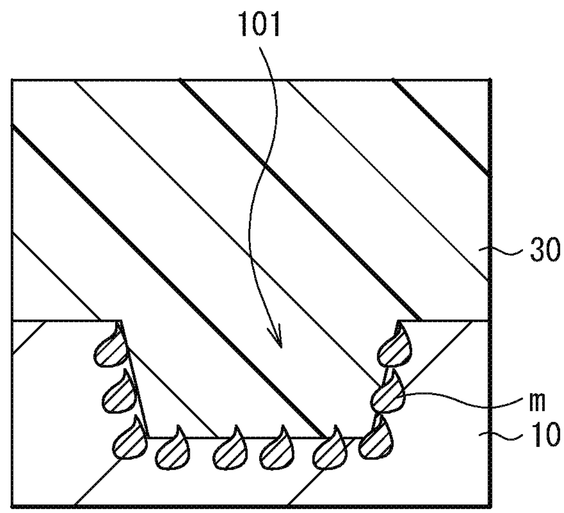
[FIG. 6C]



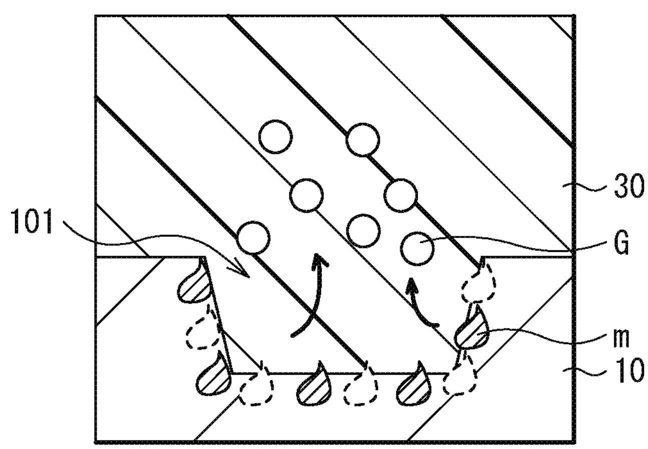
[FIG. 7A]



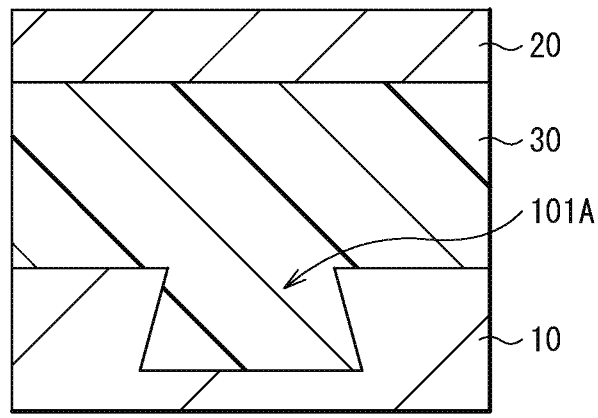
[FIG. 7B]



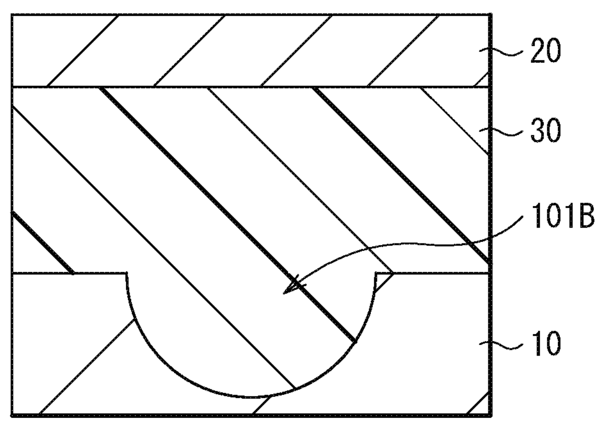
[FIG. 7C]



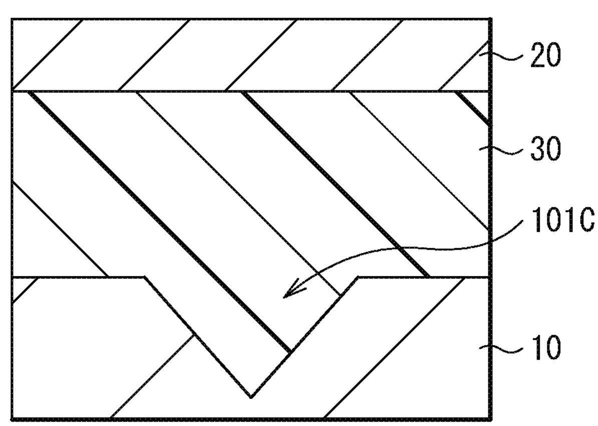
[FIG. 8A]



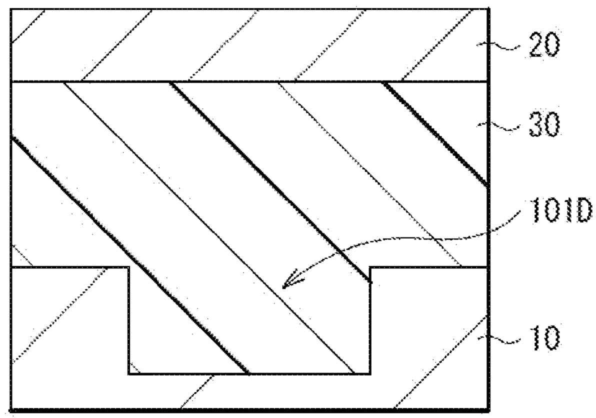
[FIG. 8B]



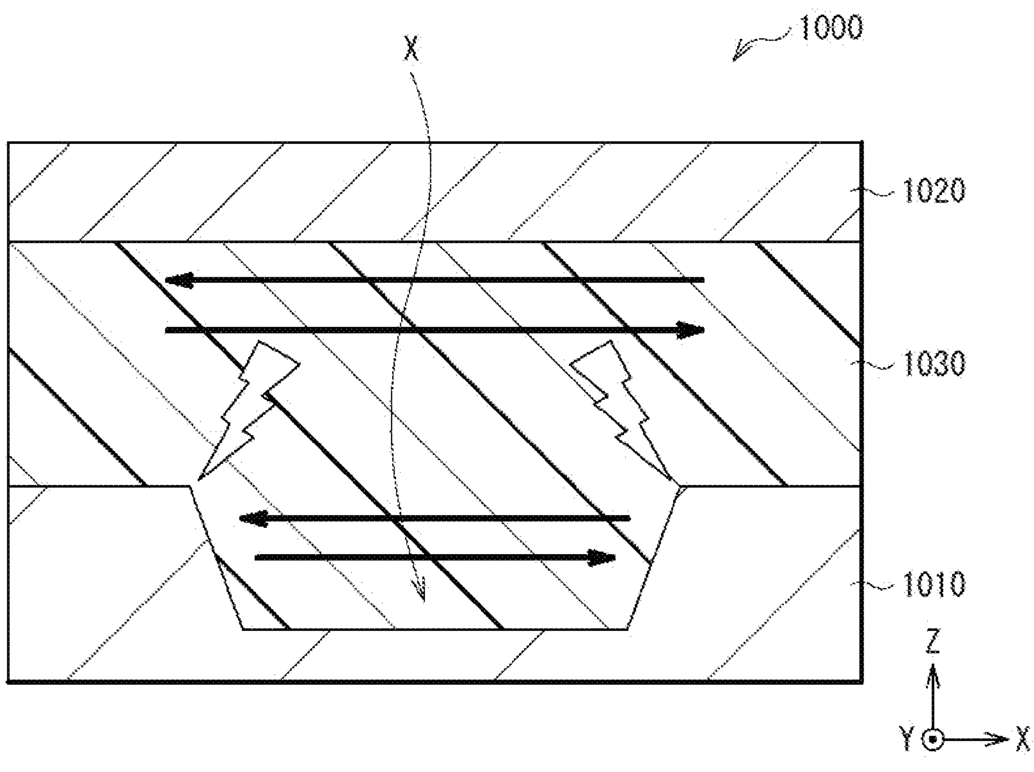
[FIG. 8C]



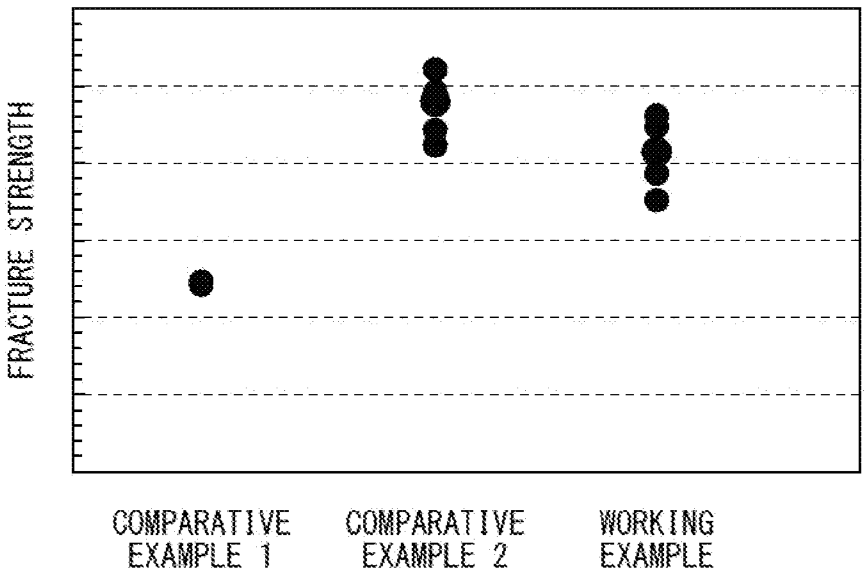
[FIG. 8D]



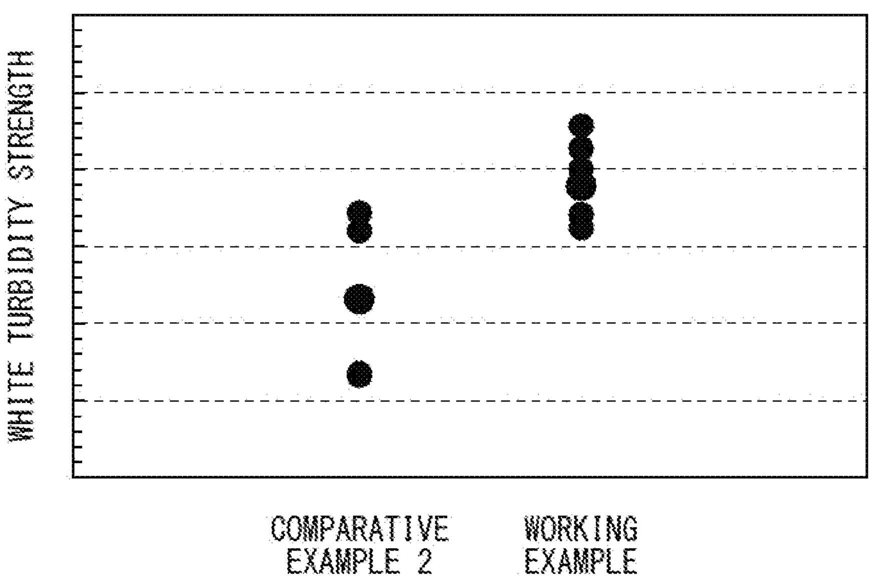
[FIG. 9]



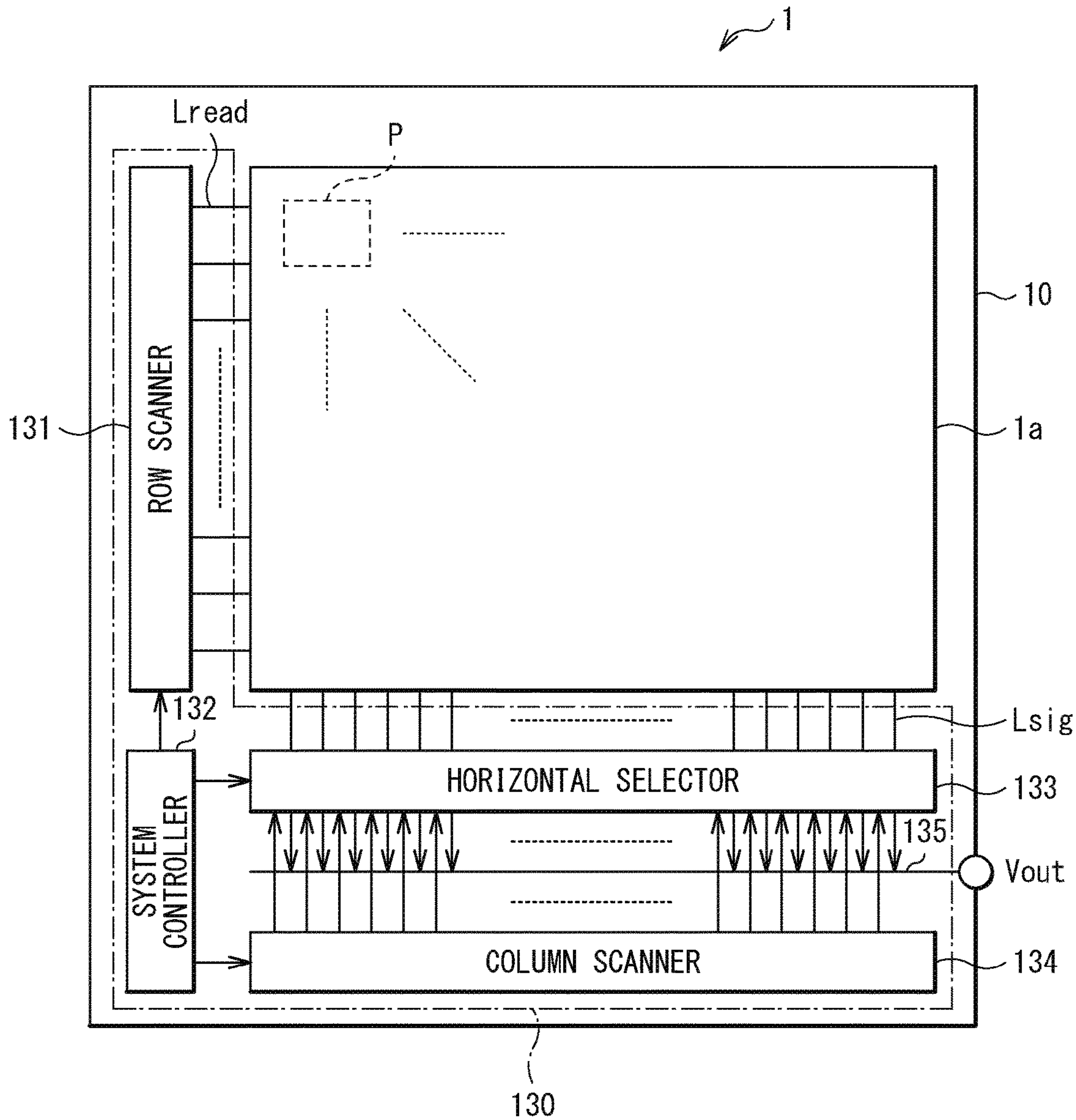
[FIG. 10]


FRACTURE STRENGTH
COMPARATIVE EXAMPLE 1
COMPARATIVE EXAMPLE 2
WORKING EXAMPLE

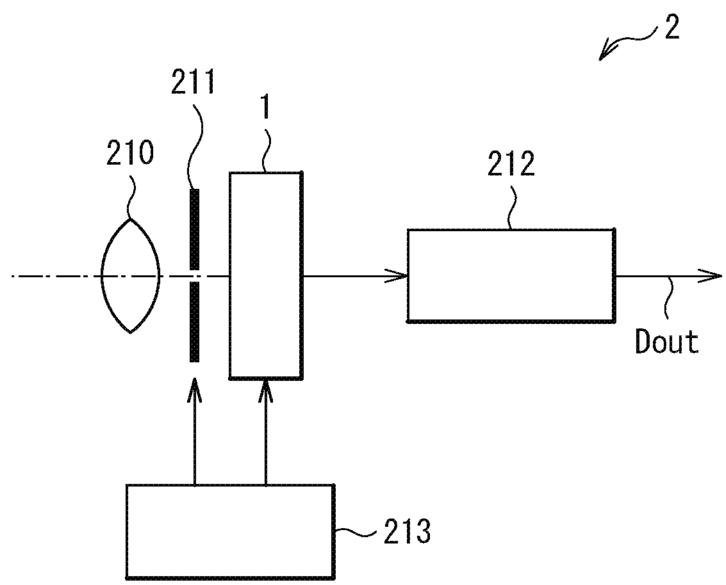
[FIG. 11]


WHITE TURBIDITY STRENGTH
COMPARATIVE EXAMPLE 2
WORKING EXAMPLE

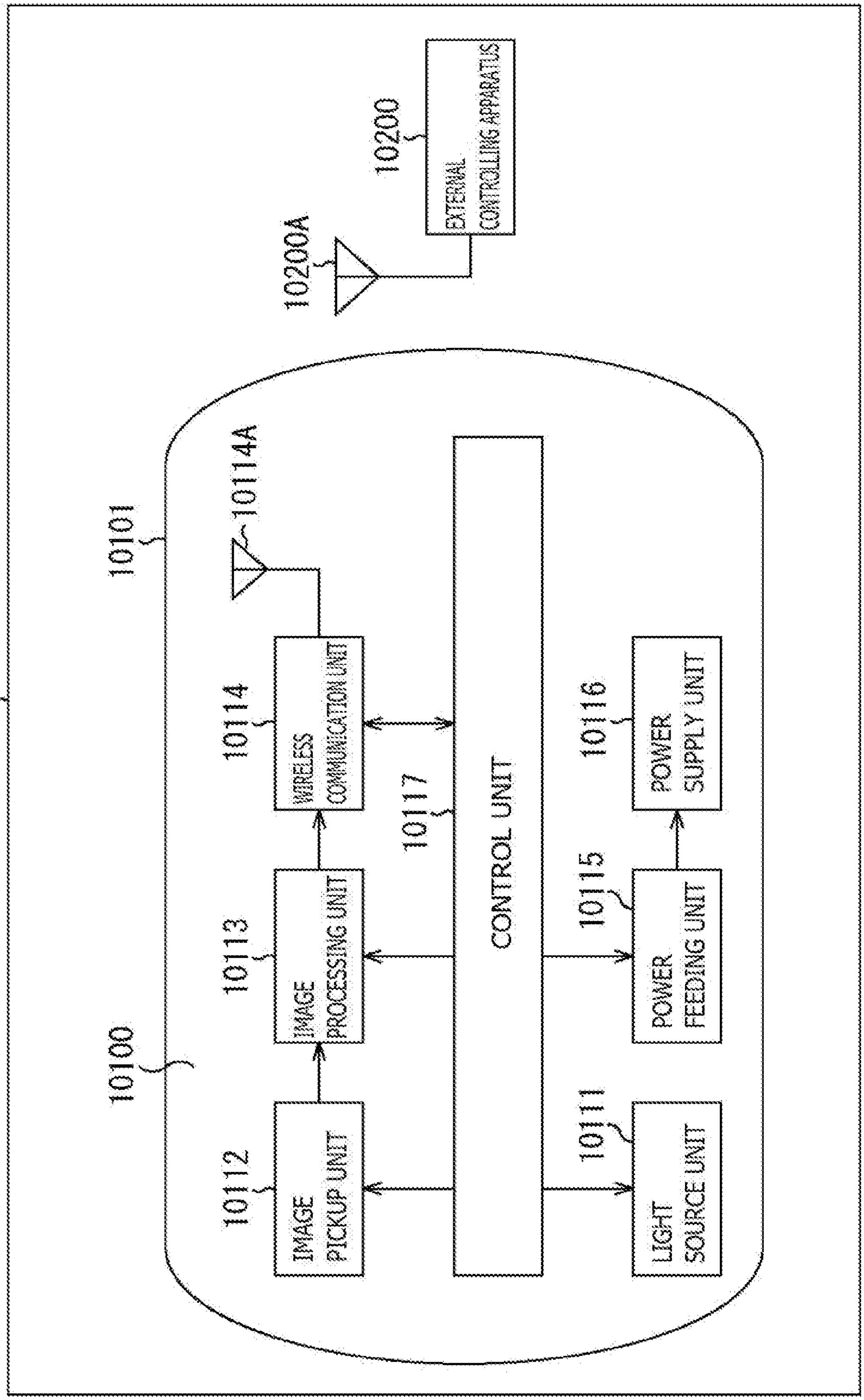
[FIG. 12]


1
Lread
P
10
131
ROW SCANNER
1a
132
Lsig
HORIZONTAL SELECTOR
133
SYSTEM CONTROLLER
135
Vout
COLUMN SCANNER
134
130

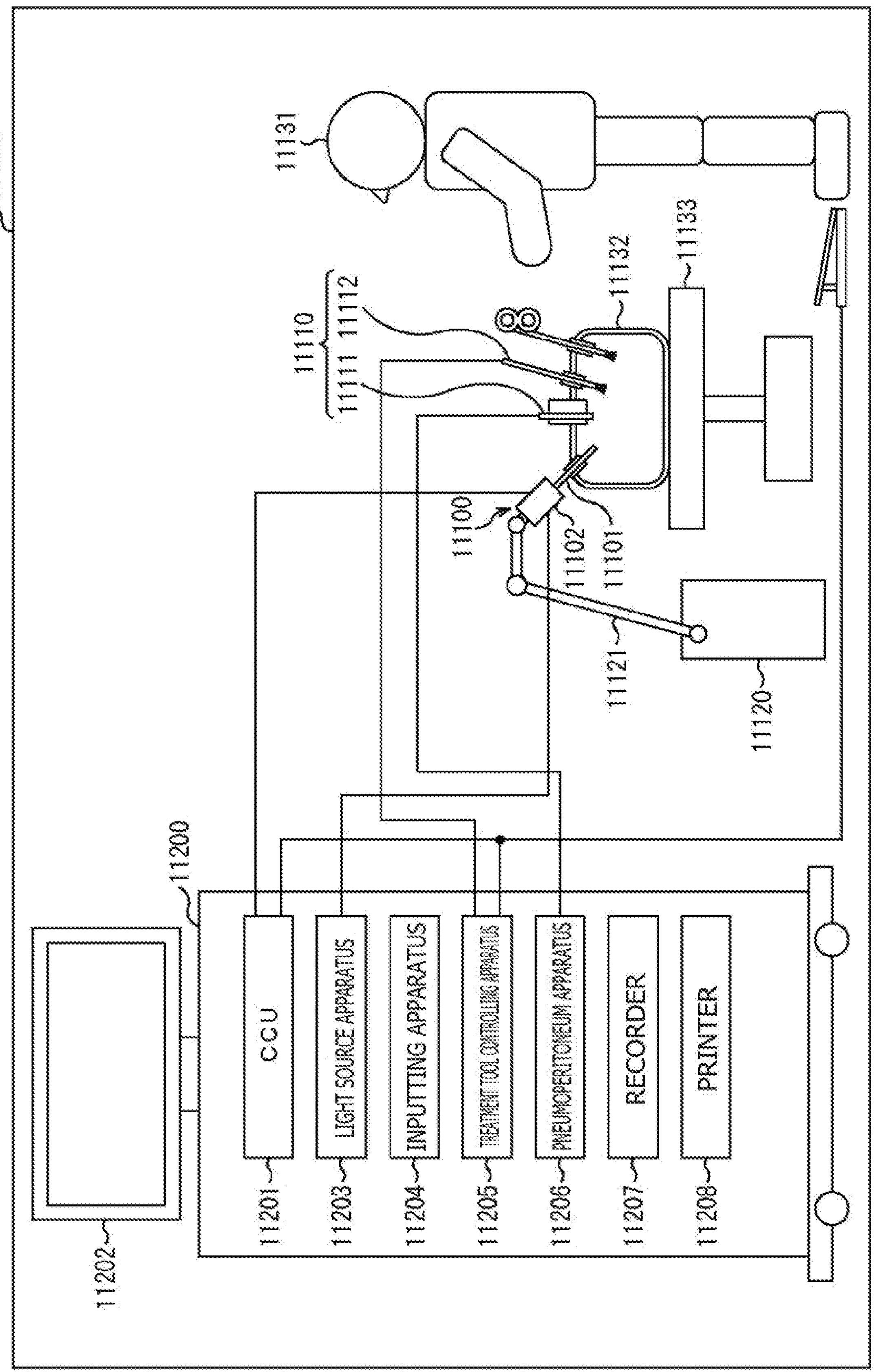
[FIG. 13]



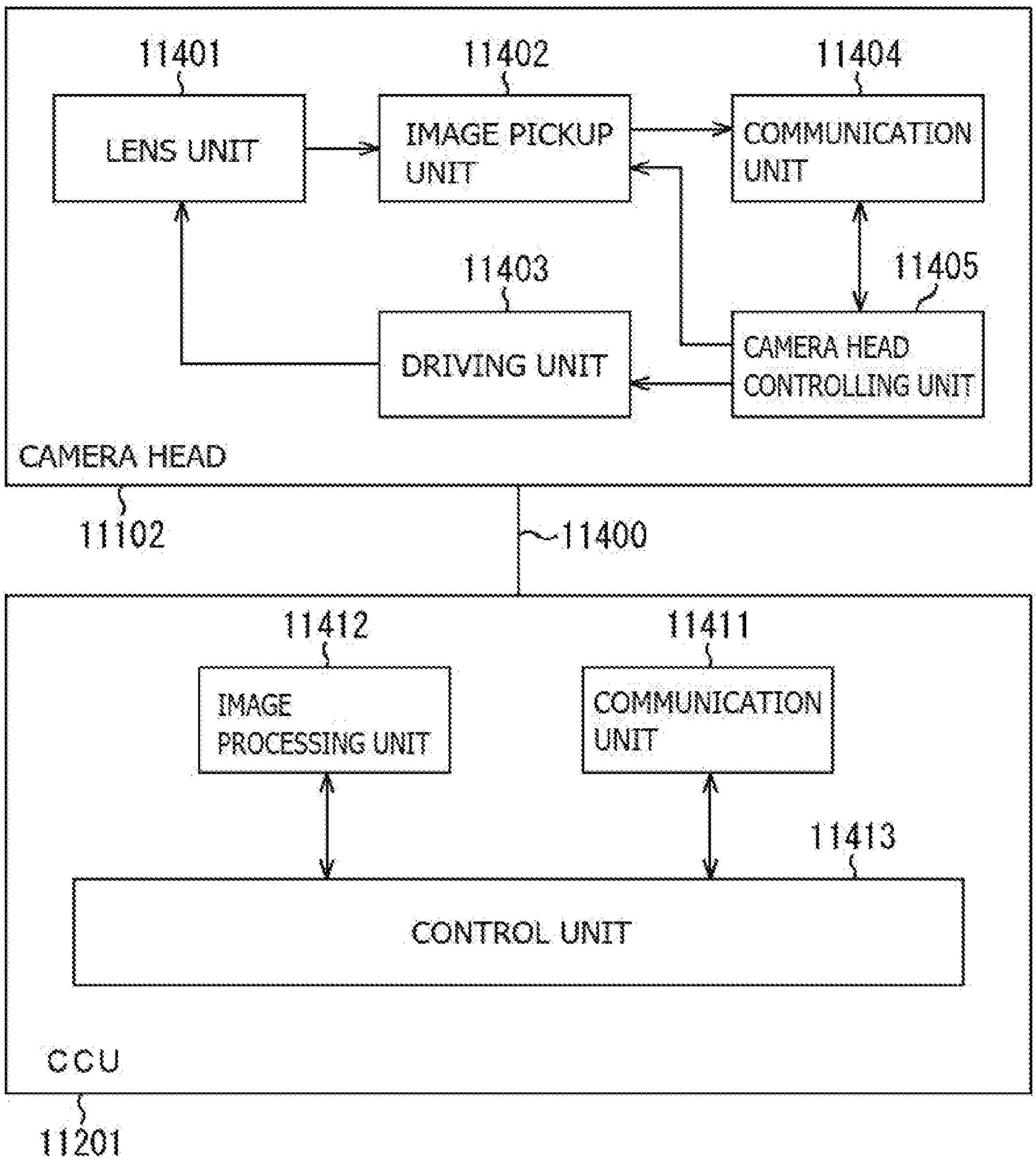
[FIG. 14]


10001
10101
10100
10200
EXTERNAL CONTROLLING APPARATUS
10200A
10114A
10112
IMAGE PICKUP UNIT
10113
IMAGE PROCESSING UNIT
10114
WIRELESS COMMUNICATION UNIT
10117
CONTROL UNIT
10111
LIGHT SOURCE UNIT
10115
POWER FEEDING UNIT
10116
POWER SUPPLY UNIT

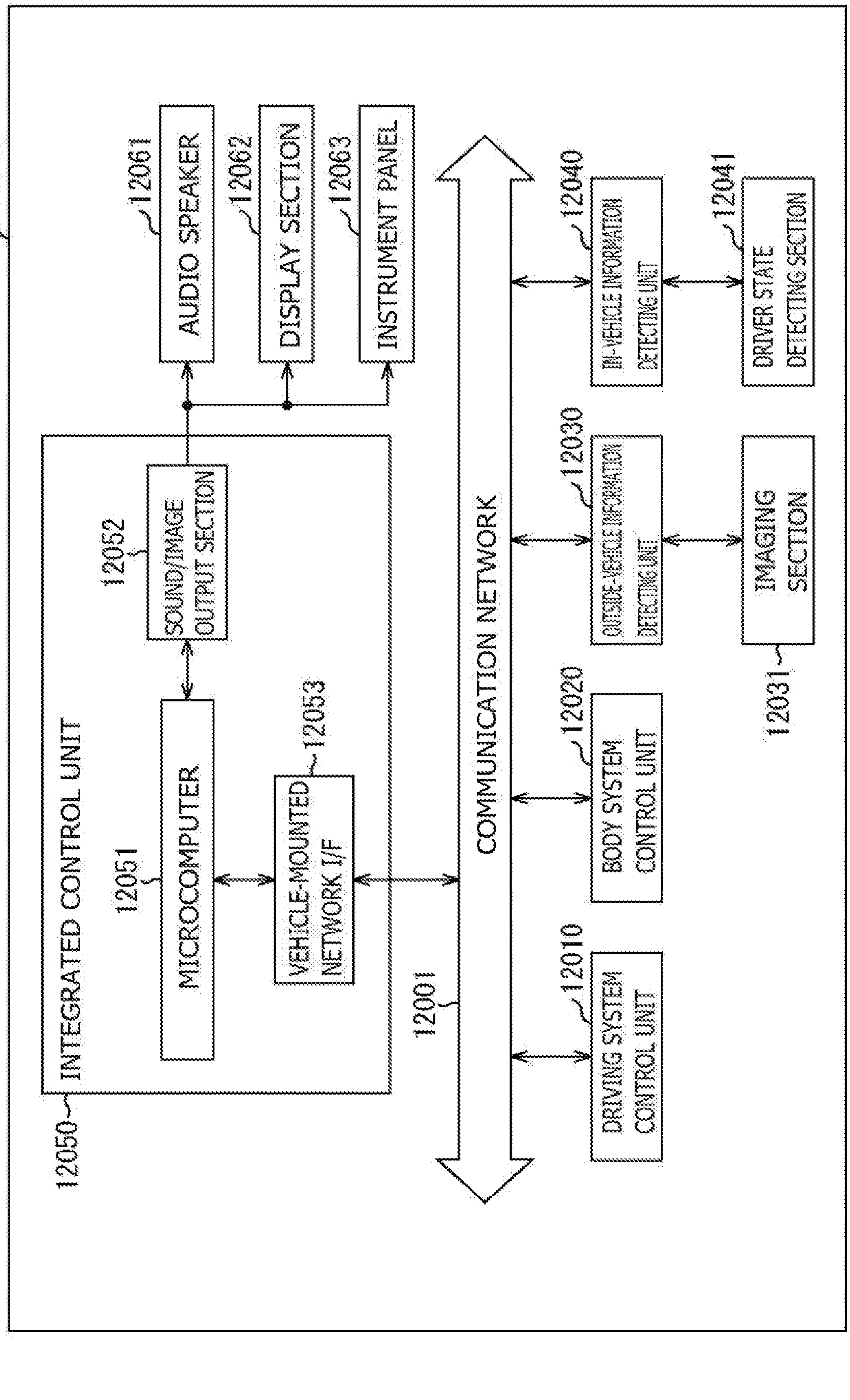
[FIG. 15]


11000
11131
11110
11111
11112
11132
11133
11100
11102
11101
11121
11120
11200
CCU
LIGHT SOURCE APPARATUS
INPUTTING APPARATUS
TREATMENT TOOL CONTROLLING APPARATUS
PNEUMOPERITONEUM APPARATUS
RECORDER
PRINTER
11201
11203
11204
11205
11206
11207
11208
11202

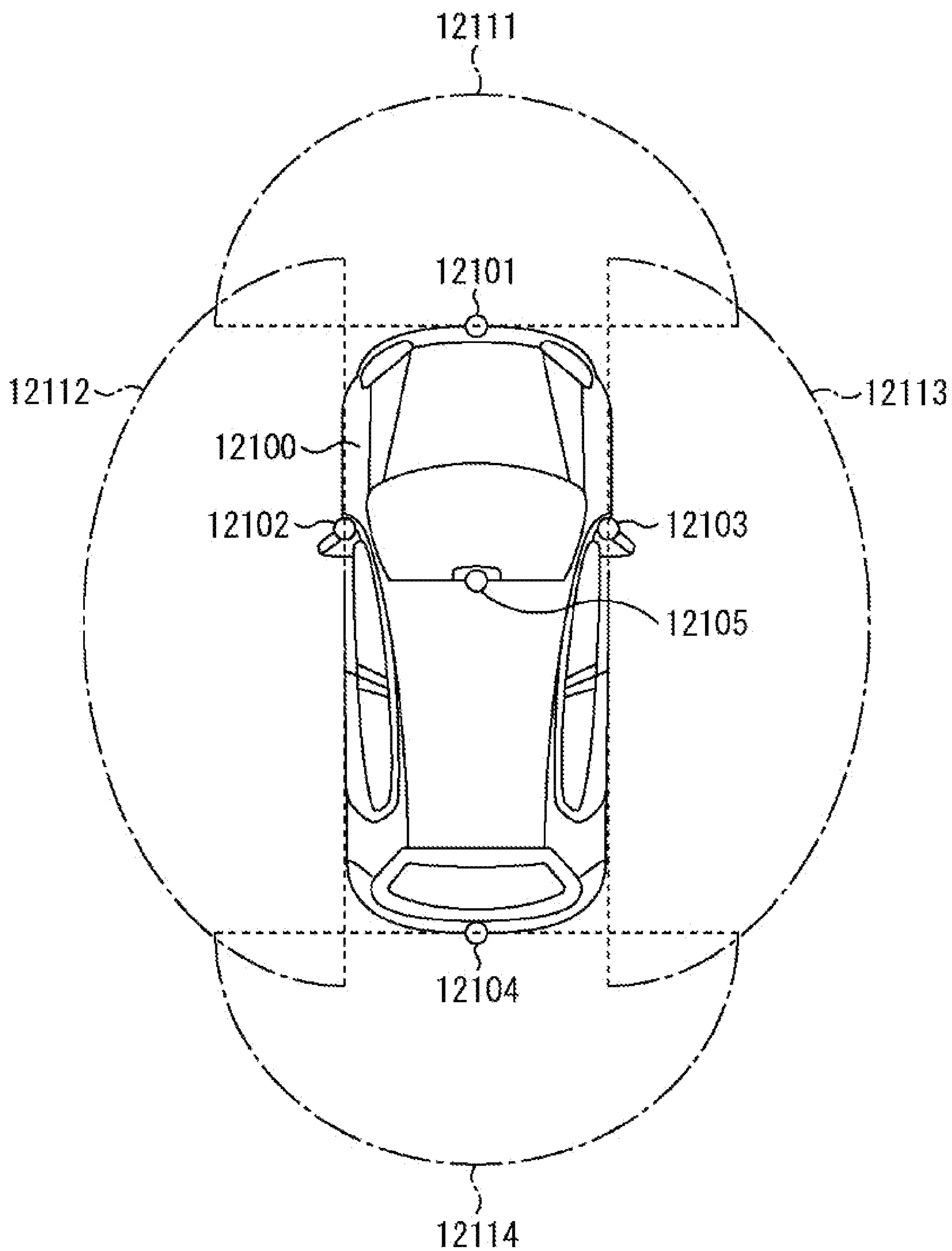
[FIG. 16]


11401
LENS UNIT
11402
IMAGE PICKUP UNIT
11404
COMMUNICATION UNIT
11405
11403
DRIVING UNIT
CAMERA HEAD CONTROLLING UNIT
CAMERA HEAD
11102
11400
11412
IMAGE PROCESSING UNIT
11411
COMMUNICATION UNIT
11413
CONTROL UNIT
CCU
11201

[FIG. 17]


12000
12050
INTEGRATED CONTROL UNIT
12051
MICROCOMPUTER
12052
SOUND/IMAGE OUTPUT SECTION
12053
VEHICLE-MOUNTED NETWORK I/F
12061
AUDIO SPEAKER
12062
DISPLAY SECTION
12063
INSTRUMENT PANEL
12001
COMMUNICATION NETWORK
12010
DRIVING SYSTEM CONTROL UNIT
12020
BODY SYSTEM CONTROL UNIT
12030
OUTSIDE-VEHICLE INFORMATION DETECTING UNIT
12031
IMAGING SECTION
12040
IN-VEHICLE INFORMATION DETECTING UNIT
12041
DRIVER STATE DETECTING SECTION

[FIG. 18]


12111
12101
12112
12113
12100
12102
12103
12105
12104
12114

IMAGING ELEMENT AND ELECTRONIC APPARATUS

TECHNICAL FIELD

[0001] The present disclosure relates to, for example, an imaging element with an optical sensor configured as a chip-scale package, and an electronic apparatus including the imaging element.

BACKGROUND ART

[0002] A wafer chip scale package (Wafer Chip Scale Package; WCSP) structure has been proposed as a simple package method for an optical sensor. The WCSP structure involves performing processing of adhering a silicon substrate and a glass substrate to each other, and the adhesive structure needs to be appropriately addressed. For example, PTL 1 discloses an imaging element provided with an excavated part in the vicinity of four corners of an outer peripheral region outside an effective pixel region of a sensor substrate in a structure in which the sensor substrate, a seal resin, and a sealing glass are stacked in order. A seal resin is embedded in the excavated part to thereby improve share strength of a joint part and thus to achieve an improvement in reliability.

CITATION LIST

Patent Literature

[0003] PTL 1: Japanese Unexamined Patent Application Publication No. 2013-41878

SUMMARY OF THE INVENTION

[0004] As described above, the imaging element is required to improve the reliability.

[0005] It is desirable to provide an imaging element and an electronic apparatus that make it possible to improve reliability.

[0006] An imaging element according to an embodiment of the present disclosure includes: a sensor substrate having a light-receiving region in which a plurality of light-receiving elements are arranged and a peripheral region provided around the light-receiving region; a sealing member disposed to be opposed to one surface of the sensor substrate; a resin layer that attaches the sensor substrate and the sealing member to each other; and an excavated part provided in the peripheral region of the one surface of the sensor substrate, and in which the resin layer is embedded, with the resin layer having one or a plurality of gaps inside the excavated part in a plan view.

[0007] An electronic apparatus according to an embodiment of the present disclosure includes, as an imaging element, the imaging element according to an embodiment of the present disclosure.

[0008] In the imaging element and the electronic apparatus of respective embodiments of the present disclosure, the excavated part is provided in the peripheral region of the sensor substrate having the light-receiving region in which the plurality of light-receiving elements are arranged. The resin layer that attaches the sensor substrate and the sealing member to each other is embedded in the excavated part, and the one or the plurality of gaps are provided in the resin layer embedded in the excavated part in a plan view. This reduces application of local stress to the excavated part.

[0009] According to the imaging element and the electronic apparatus of the respective embodiments of the present disclosure, the excavated part is provided in the peripheral region of the sensor substrate to which the sealing member is attached with the resin layer interposed therebetween, and the one or the plurality of gaps are provided in the resin layer embedded in the excavated part in a plan view. This reduces application of local stress to the excavated part, enabling prevention of breakage of the resin layer. Thus, it is possible to improve reliability.

[0010] It is to be noted that the effects described here are not necessarily limitative, and may be any of the effects described in the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is a schematic cross-sectional view of an example of a configuration of a main part of an imaging element according to an embodiment of the present disclosure.

[0012] FIG. **2** is a schematic cross-sectional view of an overall configuration of the imaging element illustrated in FIG. **1**.

[0013] FIG. **3** is a schematic plan view of the overall configuration of the imaging element illustrated in FIG. **1**.

[0014] FIG. **4**A is a schematic cross-sectional view of another example of positions of gaps in the imaging element illustrated in FIG. **1**.

[0015] FIG. **4**B is a schematic cross-sectional view of another example of the positions of the gaps in the imaging element illustrated in FIG. **1**.

[0016] FIG. **4**C is a schematic cross-sectional view of another example of the positions of the gaps in the imaging element illustrated in FIG. **1**.

[0017] FIG. **5** is a schematic cross-sectional view of another example of the configuration of the main part of the imaging element illustrated in FIG. **1**.

[0018] FIG. **6**A is a schematic cross-sectional view of another example of a position of a gap in the imaging element illustrated in FIG. **5**.

[0019] FIG. **6**B is a schematic cross-sectional view of another example of the position of the gap in the imaging element illustrated in FIG. **5**.

[0020] FIG. **6**C is a schematic cross-sectional view of another example of positions of gaps in the imaging element illustrated in FIG. **5**.

[0021] FIG. **7**A is an explanatory schematic cross-sectional view of a manufacturing method of the imaging element illustrated in FIG. **1**.

[0022] FIG. **7**B is a schematic cross-sectional view of a step subsequent to FIG. **7**A.

[0023] FIG. **7**C is a schematic cross-sectional view of a step subsequent to FIG. **7**B.

[0024] FIG. **8**A is a schematic cross-sectional view of another example of a shape of an excavated part of the imaging element illustrated in FIG. **1**.

[0025] FIG. **8**B is a schematic cross-sectional view of another example of the shape of the excavated part of the imaging element illustrated in FIG. **1**.

[0026] FIG. **8**C is a schematic cross-sectional view of another example of the shape of the excavated part of the imaging element illustrated in FIG. **1**.

[0027] FIG. **8**D is a schematic cross-sectional view of another example of the shape of the excavated part of the imaging element illustrated in FIG. **1**.

[0028] FIG. **9** is a schematic cross-sectional view of a configuration of a main part of an imaging element as a comparative example.

[0029] FIG. **10** illustrates fracture strength characteristics of Comparative Examples 1 and 2 and the embodiment.

[0030] FIG. **11** illustrates white turbidity strength characteristics of Comparative Examples 1 and 2 and the embodiment.

[0031] FIG. **12** is a block diagram illustrating a configuration of the imaging element illustrated in FIG. **1**.

[0032] FIG. **13** is a functional block diagram illustrating an example of an electronic apparatus (camera) using the imaging element illustrated in FIG. **12**.

[0033] FIG. **14** is a block diagram depicting an example of a schematic configuration of an in-vivo information acquisition system.

[0034] FIG. **15** is a view depicting an example of a schematic configuration of an endoscopic surgery system.

[0035] FIG. **16** is a block diagram depicting an example of a functional configuration of a camera head and a camera control unit (CCU).

[0036] FIG. **17** is a block diagram depicting an example of schematic configuration of a vehicle control system.

[0037] FIG. **18** is a diagram of assistance in explaining an example of installation positions of an outside-vehicle information detecting section and an imaging section.

MODES FOR CARRYING OUT THE INVENTION

[0038] In the following, description is given in detail of an embodiment of the present disclosure with reference to the drawings. The following description is merely a specific example of the present disclosure, and the present disclosure should not be limited to the following aspects. Moreover, the present disclosure is not limited to arrangements, dimensions, dimensional ratios, and the like of each component illustrated in the drawings. It is to be noted that the description is given in the following order.

[0039] 1. Embodiment (An example in which a black layer is provided on a light-shielding layer provided on an organic photoelectric conversion layer)

[0040] 1-1. Configuration of Imaging Element

[0041] 1-2. Configuration of Excavated Part and Vicinity Thereof

[0042] 1-3. Workings and Effects

[0043] 2. Application Examples

1. EMBODIMENT

[0044] FIG. **1** schematically illustrates a cross-sectional configuration of a main part of an imaging element (an imaging element **1**) according to an embodiment of the present disclosure. FIG. **2** schematically illustrates an overall cross-sectional configuration of the imaging element **1** illustrated in FIG. **1**. FIG. **3** schematically illustrates an overall planar configuration of the imaging element **1** illustrated in FIG. **1**. FIG. **1** illustrates a portion of a cross-sectional configuration taken along a line I-I indicated in FIG. **3**, and FIG. **2** illustrates a cross-sectional configuration taken along a line II-II indicated in FIG. **3**. The imaging element **1** is, for example, a backside illumination type (backside light-reception type) CCD (Charge Coupled Device) image sensor or CMOS (Complementary Metal Oxide Semiconductor) image sensor, etc. The imaging element **1** of the present embodiment is an imaging element having a so-called WCSP structure, that is packaged by attaching a sealing member **20** onto a sensor substrate **10**, in which a plurality of light-receiving elements **11** are arranged, with a resin layer **30** interposed therebetween. In the imaging element **1**, a back surface (a surface S**1**; one surface) of the sensor substrate **10** is provided with an excavated part **101**. The resin layer **30** is embedded in the excavated part **101**, and a plurality of gaps G are configured to be formed inside the excavated part **101** in a plan view.

(1-1. Configuration of Imaging Element)

[0045] The imaging element **1** has a configuration in which the sensor substrate **10**, the resin layer **30**, and the sealing member **20** are stacked in this order. The sensor substrate **10** has a light-receiving region **100**A in which the plurality of light-receiving elements **11** are arranged in an array state on side of the back surface (surface S**1**), and a peripheral region **100**B in the vicinity thereof. The peripheral region **100**B is provided with the excavated part **101** in the vicinity of each of four corners, for example, as described above. The resin layer **30** is embedded in the excavated part **101**, and the plurality of gaps G are formed in the resin layer **30** embedded in the excavated part **101**. For example, a support substrate **40** is attached to a front surface (a surface S**2**; the other surface) of the sensor substrate **10**.

[0046] The sensor substrate **10** has the light-receiving region **100**A and the peripheral region **100**B in the periphery thereof. The light-receiving region **100**A includes, on the side of the back surface (surface S**1**), the light-receiving elements **11** that selectively detect light in mutually different wavelength regions for each unit pixel P (see, e.g., FIG. **12**) to perform photoelectric conversion. The light-receiving element **11** includes, for example, a photodiode or the like; the light-receiving element **11** is embedded and formed in the back surface (surface S**1**) of the sensor substrate **10**, for example, and constitutes a light-receiving surface. The peripheral region **100**B is provided with, for example, a peripheral circuit (a peripheral circuit section **130**) including a row scanner **131**, a horizontal selector **133**, a column scanner **134**, and a system controller **132** (see, e.g., FIG. **12**).

[0047] A color filter **12** is provided on the light-receiving element **11**, for example. As for the color filter **12**, color filters of red (R), green (G) and blue (B), which are three primary colors, are arranged in a Bayer manner, for example, in the light-receiving region **100**A.

[0048] An on-chip lens **13** is further provided over the light-receiving element **11**, with the color filter **12** interposed therebetween. The on-chip lens **13** is provided for condensing incident light on the light-receiving element **11**, and is configured by a material having light-transmissivity. Examples of the material having light-transmissivity include a transparent resin material such as an acrylic material, silicon oxide (SiO), silicon nitride (SiN), and silicon oxynitride (SiON). The on-chip lens **13** is configured by a monolayer film including one of those described above, or a stacked film including two or more thereof.

[0049] It is to be noted that another layer may be provided between the light-receiving element **11** and the on-chip lens **13**; for example, an optical filter such as an anti-reflection layer or an infrared cut filter may be provided on the color filter **12**.

[0050] For example, a pixel transistor is formed and a multilayer wiring layer is provided on side of the front surface (surface S2 on side opposite to the light-receiving surface) of the sensor substrate **10**.

[0051] The sealing member **20** is a member having light-transmissivity for sealing the light-receiving region **100**A of the sensor substrate **10**. As the sealing member **20**, for example, a glass substrate is used, but this is not limitative. For example, an acrylic resin substrate, a sapphire substrate, or the like may be used.

[0052] The resin layer **30** is provided for attaching the sensor substrate **10** and the sealing member **20** to each other in a region including at least the light-receiving region **100**A. A resin material with optical characteristics (refractive index, extinction coefficient, etc.) being prioritized is selected for the resin layer **30**, for example, to enable the light-receiving element **11** to favorably receive light incident on the imaging element **1**. Examples of the material of the resin layer **30** include a siloxane-based resin material, an acrylic-based resin material, a styrene-based resin material, and an epoxy-based resin material. Alternatively, a configuration may be adopted, in which an inorganic film such as SiO (silicon oxide) or SiN (silicon nitride) is used, instead of the resin of the organic material, as the resin layer **30** to join the sensor substrate **10** and the sealing member **20** together.

[0053] The support substrate **40** is provided for supporting the sensor substrate **10**. A signal processing circuit or the like that performs signal processing on a pixel signal outputted from the sensor substrate **10** may be formed, for example, in the support substrate **40**.

(1-2. Configuration of Excavated Part and Vicinity Thereof)

[0054] As described above, in the imaging element **1** of the present embodiment, the back surface (surface S**1**; one surface) of the sensor substrate **10** to be attached to the sealing member **20** is provided with the excavated part **101** in the peripheral region **100**B.

[0055] As illustrated in FIG. **3**, for example, four excavated parts **101** are provided in respective vicinities of the four corners of the peripheral region **100**B, for example, and are formed in respective similar cross-sectional shapes. Specifically, as illustrated in FIG. **1**, the excavated part **101** is formed as a recess part having a trapezoidal cross-sectional shape with a tapered surface narrowing in a depth direction. Examples of the size of the excavated part **101** include 100 μm×100 μm with a depth of 5 μm, but this is not limitative. The resin layer **30** is embedded in the excavated part **101**.

[0056] In the present embodiment, the plurality of gaps G are formed in the resin layer **30** embedded inside the excavated part **101** in a plan view, and the excavated part **101** and the resin layer **30** in the vicinity thereof have rigidity lower than that of the surrounding.

[0057] The gap G formed in the resin layer **30** has a nanobubble structure containing a plurality of bubbles each having a mean hole diameter of 30 nm to 300 nm, for example. As illustrated in FIG. **1**, the plurality of gaps G formed as the nanobubble structure are preferably provided inside and above the excavated part **101** in a side view, but this is not limitative. For example, as illustrated in FIG. **4**A, the plurality of gaps G may be formed only in the recess part formed as the excavated part **101**. Alternatively, as illustrated in FIG. **4**B, the plurality of gaps G may be formed only above the excavated part **101**. Alternatively, as illustrated in FIG. **4**C, the plurality of gaps G may be formed separately in two region **31**A and **31**B, i.e., inside the recess part formed as the excavated part **101** and above the recessed part.

[0058] In addition, as illustrated in FIG. **5**, the gap G formed in the resin layer **30** has a microbubble structure having a mean hole diameter of 10 μm to 30 μm, and may be formed as a single bubble, for example. As illustrated in FIG. **4**, the gap G formed as the microbubble structure is preferably provided at positions hanging inside and above the excavated part **101** in a side view, but this is not limitative. For example, as illustrated in FIG. **6**A, the gap G may be formed to be accommodated in the recessed part formed as the excavated part **101**. Alternatively, as illustrated in FIG. **6**B, the gap G may be formed above the excavated part **101**. Alternatively, as illustrated in FIG. **6**C, the gap G may be formed one by one inside and above the recessed part formed as the excavated part **101**.

[0059] That is, it is sufficient for one or a plurality of gaps G to be formed inside the excavated part **101** and in the resin layer **30** in the vicinity thereof, and the size, the shape, and the number thereof do not particularly matter.

[0060] Further, air is usually contained in the gap G, but this is not limitative. For example, the gap G may be filled with a material softer than the resin layer **30**, such as rubber or a resin material having lower strength.

[0061] The gap G as described above may be formed, for example, as follows.

[0062] First, in order to cause a location for formation of the excavated part **101** to open, a region other than the location for formation of the excavated part **101** on the sensor substrate **10** is patterned using a photoresist. Subsequently, for example, dry etching is performed to form the excavated part **101** at a position where the photoresist is opened, and thereafter ashing, for example, is performed to remove a side surface (a surface S**101**) after the etching, as illustrated in FIG. **7**A.

[0063] Next, as illustrated in FIG. **7**B, gaseous components such as moisture are adsorbed to the side surface and a bottom surface that constitute the excavated part **101**, and thereafter a resin material serving as the resin layer **30** is applied onto the entire surface of the sensor substrate **10**. At this time, the resin material is applied to fill the excavated part **101** as well.

[0064] Subsequently, as illustrated in FIG. **7**C, performing heating treatment on the sensor substrate **10** to thereby cause the moisture or the like adsorbed to the side surface and the bottom surface of the excavated part **101** to be vaporized, thus forming the one or the plurality of gaps G inside the excavated part **101** and in the vicinity thereof.

[0065] It is to be noted that the shape of the excavated part **101** is not limited. FIG. **1** exemplifies the excavated part **101** having a trapezoidal cross-sectional shape with a tapered surface narrowing in the depth direction, but this is not limitative; for example, shapes as illustrated in FIG. **8**A to FIG. **8**D may be adopted.

[0066] For example, the excavated part **101** may be a recessed part having a trapezoidal cross-sectional shape with a tapered surface expanding in the depth direction, as in an excavated part **101**A illustrated in FIG. **8**A. In addition, the excavated part **101** may be a recessed part having a concave curved cross-sectional shape, as in an excavated part **101**B illustrated in FIG. **8**B. Further, the excavated part **101** may be a recessed part having a triangular cross-sectional shape with a tapered surface having an apex, as in an excavated part **101**C illustrated in FIG. **8**C. Furthermore, the excavated part **101** may be a recessed part having a rectangular cross-sectional shape, in which the side surface is substantially orthogonal to the surface **51** of the sensor substrate **10**, as in an excavated part **101**D illustrated in FIG. **8**D.

(1-3. Workings and Effects)

[0067] As described above, the WCSP structure involves performing processing of attaching a silicon substrate and a glass substrate to each other, and the adhesive structure needs to be appropriately addressed. For this reason, a method has been proposed that provides excavated parts in respective vicinities of four corners of an outer peripheral region outside an effective pixel region of a sensor substrate, and fills the excavated parts with a seal resin to attach the silicon substrate and the glass substrate to each other to thereby improve share strength of a joint part.

[0068] FIG. **9** schematically illustrates a cross-sectional configuration of an excavated part X of an imaging element (an imaging element **1000**) having the above-described structure and the periphery thereof. In a structure in which the excavated part X provided in a sensor substrate **1010** is filled with a seal resin as in the imaging element **1000**, a resin layer **1030** provided between the sensor substrate **1010** and a sealing member **1020** differs in an amount of change in a planar direction (e.g., an X-axis direction) due to contraction or expansion between the inside of the excavated part X and other regions, as indicated by arrows. Such a difference leads to a possibility that the resin layer **1030** may break due to local stress being applied to corner portions of the excavated part X, for example.

[0069] As a method for solving this issue, methods are conceivable to allow the inside of the excavated part X to be a cavity so as not to provide a step in the resin layer **1030**, or to fill the inside of the excavated part X as well as the excavated part X and a region thereabove with a material different from those for other regions. However, in the above-described methods, there is a possibility that adhesive strength between the sensor substrate **1010** and the resin layer **1030** may be lowered, or that the manufacturing steps may be complicated.

[0070] In contrast, in the imaging element **1** of the present embodiment, the formation of the one or the plurality of gaps G in the excavated part **101**, or in the resin layer **300** in the vicinity thereof, provided in the peripheral region **100**B of the sensor substrate **10** allows the stress applied to the corner portions or the like of the excavated part **101** due to the contraction or expansion of the resin layer **30** to be relieved.

[0071] FIG. **10** illustrates fracture strength characteristics of respective resin layers (e.g., resin layer **30**) in an imaging element (Comparative Example 1) having no excavated part in the peripheral region of the sensor substrate, in the imaging element **1000** (Comparative Example 2) having the above-described structure, and in the imaging element **1** (embodiment) of the present embodiment. In comparison with Comparative Example 1 having no excavated part, Comparative Example 2 and the embodiment each having the excavated part obtain equivalent fracture strength regardless of the internal structure of the excavated part.

[0072] FIG. **11** illustrates white turbidity strength characteristics of the respective resin layers (e.g., resin layer **30**) in the imaging element **1000** (Comparative Example 2) having the above-described structure and the imaging element **1** (embodiment) of the present embodiment. The white turbidity strength refers to a strength at which the resin starts to become white and turbid upon application of stress, and indicates that the higher the strength becomes, the less likely a photographed or shot image is influenced, for example. In comparison with Comparative Example 2 in which the excavated part X is completely filled with the resin layer **1030**, in the embodiment in which the gap G is provided in the excavated part **101**, it is possible to confirm an improvement in the white turbidity strength.

[0073] As described above, in the imaging element **1** of the present embodiment, the one or the plurality of gaps G are provided in the resin layer **30** embedded in the excavated part **101** provided in the peripheral region **100**B of the sensor substrate **10**. This makes it possible to reduce the application of local stress to the corner portions or the like of the excavated part **101**, and thus to prevent breakage of the resin layer **30**. Thus, it becomes possible to improve reliability.

[0074] In addition, in the present embodiment, generation of white turbidity due to the breakage or the like of the resin layer **30** is reduced, thus making it also possible to improve a manufacturing yield and a design property.

2. APPLICATION EXAMPLES

Application Example 1

[0075] FIG. **12** is a block diagram illustrating an overall configuration of the imaging element **1** described in the foregoing embodiment. The imaging element **1** is a CMOS imaging sensor. The imaging element **1** includes a pixel section **1***a* as an imaging area on the sensor substrate **10**, and includes, for example, the peripheral circuit section **130** configured by the row scanner **131**, the horizontal selector **133**, the column scanner **134**, and the system controller **132** in a peripheral region of the pixel section **1***a*.

[0076] The pixel section **1***a* includes, for example, a plurality of unit pixels P (corresponding to the imaging element **1**) arranged two-dimensionally in matrix. To the unit pixels P, for example, pixel drive lines Lread (specifically, row selection lines and reset control lines) are wired on a pixel-row basis, and vertical signal lines Lsig are wired on a pixel-column basis. The pixel drive line Lread transmits a drive signal for reading of a signal from the pixel. One end of the pixel drive line Lread is coupled to an output terminal corresponding to each row in the row scanner **131**.

[0077] The row scanner **131** is configured by a shift register, an address decoder, etc. The row scanner **131** is, for example, a pixel driver that drives the respective unit pixels P in the pixel section **1***a* on a row-unit basis. Signals outputted from the respective unit pixels P in the pixel row selectively scanned by the row scanner **131** are supplied to the horizontal selector **133** via the respective vertical signal lines Lsig. The horizontal selector **133** is configured by an amplifier, a horizontal selection switch, etc., that are provided for each vertical signal line Lsig.

[0078] The column scanner **134** is configured by a shift register, an address decoder, etc. The column scanner **134** sequentially drives the respective horizontal selection switches in the horizontal selector **133** while scanning the respective horizontal selection switches in the horizontal selector **133**. As a result of the selective scanning by the column scanner **134**, signals of the respective pixels to be transmitted via the respective vertical signal lines Lsig are sequentially outputted to horizontal signal lines **135**, and are transmitted to the outside of the sensor substrate **10** through the horizontal signal lines **135**.

[0079] A circuit part configured by the row scanner **131**, the horizontal selector **133**, the column scanner **134**, and the horizontal signal lines **135** may be formed directly on the sensor substrate **10**, or may be arranged in an external control IC. Alternatively, the circuit part may be formed on another substrate coupled with use of a cable, etc.

[0080] The system controller **132** receives a clock, data instructing an operation mode, etc., that are supplied from the outside of the sensor substrate **10**. The system controller **132** also outputs data such as internal information of the imaging element **1**. The system controller **132** further includes a timing generator that generates various timing signals, and performs drive control of the peripheral circuit such as the row scanner **131**, the horizontal selector **133**, and the column scanner **134** on the basis of the various timing signals generated by the timing generator.

Application Example 2

[0081] The above-described imaging element **1** is applicable to any type of electronic apparatus having an imaging function, for example, a camera system such as a digital still camera and a video camera, and a mobile phone having the imaging function. FIG. **13** illustrates an outline configuration of an electronic apparatus **2** (camera) as an example thereof. This electronic apparatus **2** is, for example, a video camera that is able to photograph a still image or shoot a moving image. The electronic apparatus **2** includes, for example, the imaging element **1**, an optical system (optical lens) **310**, a shutter device **311**, a drive section **313** that drives the imaging element **1** and the shutter device **311**, and a signal processing section **312**.

[0082] The optical system **310** guides image light (incident light) from a subject to the pixel section **1***a* in the imaging element **1**. The optical system **310** may be configured by a plurality of optical lenses. The shutter device **311** controls periods of light irradiation and light shielding with respect to the imaging element **1**. The drive section **313** controls a transfer operation of the imaging element **1** and a shutter operation of the shutter device **311**. The signal processing section **312** performs various types of signal processing on a signal outputted from the imaging element **1**. An image signal Dout after the signal processing is stored in a storage medium such as a memory, or outputted to a monitor, etc.

[0083] Further, the above-described imaging element **1** is also applicable to electronic apparatuses (a capsule type endoscope **10100** and a mobile body such as a vehicle) described below.

Application Example 3

<Example of Practical Application to In-Vivo Information Acquisition System>

[0084] Further, the technology according to an embodiment of the present disclosure (present technology) is applicable to various products. For example, the technology according to an embodiment of the present disclosure may be applied to an endoscopic surgery system.

[0085] FIG. **14** is a block diagram depicting an example of a schematic configuration of an in-vivo information acquisition system of a patient using a capsule type endoscope, to which the technology according to an embodiment of the present disclosure (present technology) can be applied.

[0086] The in-vivo information acquisition system **10001** includes the capsule type endoscope **10100** and an external controlling apparatus **10200**.

[0087] The capsule type endoscope **10100** is swallowed by a patient at the time of inspection. The capsule type endoscope **10100** has an image pickup function and a wireless communication function and successively picks up an image of the inside of an organ such as the stomach or an intestine (hereinafter referred to as in-vivo image) at predetermined intervals while it moves inside of the organ by peristaltic motion for a period of time until it is naturally discharged from the patient. Then, the capsule type endoscope **10100** successively transmits information of the in-vivo image to the external controlling apparatus **10200** outside the body by wireless transmission.

[0088] The external controlling apparatus **10200** integrally controls operation of the in-vivo information acquisition system **10001**. Further, the external controlling apparatus **10200** receives information of an in-vivo image transmitted thereto from the capsule type endoscope **10100** and generates image data for displaying the in-vivo image on a display apparatus (not depicted) on the basis of the received information of the in-vivo image.

[0089] In the in-vivo information acquisition system **10001**, an in-vivo image imaged a state of the inside of the body of a patient can be acquired at any time in this manner for a period of time until the capsule type endoscope **10100** is discharged after it is swallowed.

[0090] A configuration and functions of the capsule type endoscope **10100** and the external controlling apparatus **10200** are described in more detail below.

[0091] The capsule type endoscope **10100** includes a housing **10101** of the capsule type, in which a light source unit **10111**, an image pickup unit **10112**, an image processing unit **10113**, a wireless communication unit **10114**, a power feeding unit **10115**, a power supply unit **10116** and a control unit **10117** are accommodated.

[0092] The light source unit **10111** includes a light source such as, for example, a light emitting diode (LED) and irradiates light on an image pickup field-of-view of the image pickup unit **10112**.

[0093] The image pickup unit **10112** includes an image pickup element and an optical system including a plurality of lenses provided at a preceding stage to the image pickup element. Reflected light (hereinafter referred to as observation light) of light irradiated on a body tissue which is an observation target is condensed by the optical system and introduced into the image pickup element. In the image pickup unit **10112**, the incident observation light is photoelectrically converted by the image pickup element, by which an image signal corresponding to the observation light is generated. The image signal generated by the image pickup unit **10112** is provided to the image processing unit **10113**.

[0094] The image processing unit **10113** includes a processor such as a central processing unit (CPU) or a graphics processing unit (GPU) and performs various signal processes for an image signal generated by the image pickup unit **10112**. The image processing unit **10113** provides the image signal for which the signal processes have been performed thereby as RAW data to the wireless communication unit **10114**.

[0095] The wireless communication unit **10114** performs a predetermined process such as a modulation process for the image signal for which the signal processes have been performed by the image processing unit **10113** and transmits the resulting image signal to the external controlling apparatus **10200** through an antenna **10114**A. Further, the wireless communication unit **10114** receives a control signal relating to driving control of the capsule type endoscope **10100** from the external controlling apparatus **10200** through the antenna **10114**A. The wireless communication unit **10114** provides the control signal received from the external controlling apparatus **10200** to the control unit **10117**.

[0096] The power feeding unit **10115** includes an antenna coil for power reception, a power regeneration circuit for regenerating electric power from current generated in the antenna coil, a voltage booster circuit and so forth. The power feeding unit **10115** generates electric power using the principle of non-contact charging.

[0097] The power supply unit **10116** includes a secondary battery and stores electric power generated by the power feeding unit **10115**. In FIG. **14**, in order to avoid complicated illustration, an arrow mark indicative of a supply destination of electric power from the power supply unit **10116** and so forth are omitted. However, electric power stored in the power supply unit **10116** is supplied to and can be used to drive the light source unit **10111**, the image pickup unit **10112**, the image processing unit **10113**, the wireless communication unit **10114** and the control unit **10117**.

[0098] The control unit **10117** includes a processor such as a CPU and suitably controls driving of the light source unit **10111**, the image pickup unit **10112**, the image processing unit **10113**, the wireless communication unit **10114** and the power feeding unit **10115** in accordance with a control signal transmitted thereto from the external controlling apparatus **10200**.

[0099] The external controlling apparatus **10200** includes a processor such as a CPU or a GPU, a microcomputer, a control board or the like in which a processor and a storage element such as a memory are mixedly incorporated. The external controlling apparatus **10200** transmits a control signal to the control unit **10117** of the capsule type endoscope **10100** through an antenna **10200**A to control operation of the capsule type endoscope **10100**. In the capsule type endoscope **10100**, an irradiation condition of light upon an observation target of the light source unit **10111** can be changed, for example, in accordance with a control signal from the external controlling apparatus **10200**. Further, an image pickup condition (for example, a frame rate, an exposure value or the like of the image pickup unit **10112**) can be changed in accordance with a control signal from the external controlling apparatus **10200**. Further, the substance of processing by the image processing unit **10113** or a condition for transmitting an image signal from the wireless communication unit **10114** (for example, a transmission interval, a transmission image number or the like) may be changed in accordance with a control signal from the external controlling apparatus **10200**.

[0100] Further, the external controlling apparatus **10200** performs various image processes for an image signal transmitted thereto from the capsule type endoscope **10100** to generate image data for displaying a picked up in-vivo image on the display apparatus. As the image processes, various signal processes can be performed such as, for example, a development process (demosaic process), an image quality improving process (bandwidth enhancement process, a super-resolution process, a noise reduction (NR) process and/or image stabilization process) and/or an enlargement process (electronic zooming process). The external controlling apparatus **10200** controls driving of the display apparatus to cause the display apparatus to display a picked up in-vivo image on the basis of generated image data. Alternatively, the external controlling apparatus **10200** may also control a recording apparatus (not depicted) to record generated image data or control a printing apparatus (not depicted) to output generated image data by printing.

[0101] The description has been given above of one example of the in-vivo information acquisition system, to which the technology according to an embodiment of the present disclosure is applicable. The technology according to an embodiment of the present disclosure is applicable to, for example, the image pickup unit **10112** of the configurations described above. This makes it possible to improve detection accuracy.

Application Example 4

<Example of Practical Application to Endoscopic Surgery System>

[0102] The technology according to an embodiment of the present disclosure (present technology) is applicable to various products. For example, the technology according to an embodiment of the present disclosure may be applied to an endoscopic surgery system.

[0103] FIG. **15** is a view depicting an example of a schematic configuration of an endoscopic surgery system to which the technology according to an embodiment of the present disclosure (present technology) can be applied.

[0104] In FIG. **15**, a state is illustrated in which a surgeon (medical doctor) **11131** is using an endoscopic surgery system **11000** to perform surgery for a patient **11132** on a patient bed **11133**. As depicted, the endoscopic surgery system **11000** includes an endoscope **11100**, other surgical tools **11110** such as a pneumoperitoneum tube **11111** and an energy device **11112**, a supporting arm apparatus **11120** which supports the endoscope **11100** thereon, and a cart **11200** on which various apparatus for endoscopic surgery are mounted.

[0105] The endoscope **11100** includes a lens barrel **11101** having a region of a predetermined length from a distal end thereof to be inserted into a body cavity of the patient **11132**, and a camera head **11102** connected to a proximal end of the lens barrel **11101**. In the example depicted, the endoscope **11100** is depicted which includes as a rigid endoscope having the lens barrel **11101** of the hard type. However, the endoscope **11100** may otherwise be included as a flexible endoscope having the lens barrel **11101** of the flexible type.

[0106] The lens barrel **11101** has, at a distal end thereof, an opening in which an objective lens is fitted. A light source apparatus **11203** is connected to the endoscope **11100** such that light generated by the light source apparatus **11203** is introduced to a distal end of the lens barrel **11101** by a light guide extending in the inside of the lens barrel **11101** and is irradiated toward an observation target in a body cavity of the patient **11132** through the objective lens. It is to be noted that the endoscope **11100** may be a forward-viewing endoscope or may be an oblique-viewing endoscope or a side-viewing endoscope.

[0107] An optical system and an image pickup element are provided in the inside of the camera head **11102** such that reflected light (observation light) from the observation target is condensed on the image pickup element by the optical system. The observation light is photo-electrically converted by the image pickup element to generate an electric signal corresponding to the observation light, namely, an image signal corresponding to an observation image. The image signal is transmitted as RAW data to a CCU **11201**.

[0108] The CCU **11201** includes a central processing unit (CPU), a graphics processing unit (GPU) or the like and integrally controls operation of the endoscope **11100** and a display apparatus **11202**. Further, the CCU **11201** receives an image signal from the camera head **11102** and performs, for the image signal, various image processes for displaying an image based on the image signal such as, for example, a development process (demosaic process).

[0109] The display apparatus **11202** displays thereon an image based on an image signal, for which the image processes have been performed by the CCU **11201**, under the control of the CCU **11201**.

[0110] The light source apparatus **11203** includes a light source such as, for example, a light emitting diode (LED) and supplies irradiation light upon imaging of a surgical region to the endoscope **11100**.

[0111] An inputting apparatus **11204** is an input interface for the endoscopic surgery system **11000**. A user can perform inputting of various kinds of information or instruction inputting to the endoscopic surgery system **11000** through the inputting apparatus **11204**. For example, the user would input an instruction or a like to change an image pickup condition (type of irradiation light, magnification, focal distance or the like) by the endoscope **11100**.

[0112] A treatment tool controlling apparatus **11205** controls driving of the energy device **11112** for cautery or incision of a tissue, sealing of a blood vessel or the like. A pneumoperitoneum apparatus **11206** feeds gas into a body cavity of the patient **11132** through the pneumoperitoneum tube **11111** to inflate the body cavity in order to secure the field of view of the endoscope **11100** and secure the working space for the surgeon. A recorder **11207** is an apparatus capable of recording various kinds of information relating to surgery. A printer **11208** is an apparatus capable of printing various kinds of information relating to surgery in various forms such as a text, an image or a graph.

[0113] It is to be noted that the light source apparatus **11203** which supplies irradiation light when a surgical region is to be imaged to the endoscope **11100** may include a white light source which includes, for example, an LED, a laser light source or a combination of them. Where a white light source includes a combination of red, green, and blue (RGB) laser light sources, since the output intensity and the output timing can be controlled with a high degree of accuracy for each color (each wavelength), adjustment of the white balance of a picked up image can be performed by the light source apparatus **11203**. Further, in this case, if laser beams from the respective RGB laser light sources are irradiated time-divisionally on an observation target and driving of the image pickup elements of the camera head **11102** are controlled in synchronism with the irradiation timings. Then images individually corresponding to the R, G and B colors can be also picked up time-divisionally. According to this method, a color image can be obtained even if color filters are not provided for the image pickup element.

[0114] Further, the light source apparatus **11203** may be controlled such that the intensity of light to be outputted is changed for each predetermined time. By controlling driving of the image pickup element of the camera head **11102** in synchronism with the timing of the change of the intensity of light to acquire images time-divisionally and synthesizing the images, an image of a high dynamic range free from underexposed blocked up shadows and overexposed highlights can be created.

[0115] Further, the light source apparatus **11203** may be configured to supply light of a predetermined wavelength band ready for special light observation. In special light observation, for example, by utilizing the wavelength dependency of absorption of light in a body tissue to irradiate light of a narrow band in comparison with irradiation light upon ordinary observation (namely, white light), narrow band observation (narrow band imaging) of imaging a predetermined tissue such as a blood vessel of a superficial portion of the mucous membrane or the like in a high contrast is performed. Alternatively, in special light observation, fluorescent observation for obtaining an image from fluorescent light generated by irradiation of excitation light may be performed. In fluorescent observation, it is possible to perform observation of fluorescent light from a body tissue by irradiating excitation light on the body tissue (autofluorescence observation) or to obtain a fluorescent light image by locally injecting a reagent such as indocyanine green (ICG) into a body tissue and irradiating excitation light corresponding to a fluorescent light wavelength of the reagent upon the body tissue. The light source apparatus **11203** can be configured to supply such narrow-band light and/or excitation light suitable for special light observation as described above.

[0116] FIG. **16** is a block diagram depicting an example of a functional configuration of the camera head **11102** and the CCU **11201** depicted in FIG. **15**.

[0117] The camera head **11102** includes a lens unit **11401**, an image pickup unit **11402**, a driving unit **11403**, a communication unit **11404** and a camera head controlling unit **11405**. The CCU **11201** includes a communication unit **11411**, an image processing unit **11412** and a control unit **11413**. The camera head **11102** and the CCU **11201** are connected for communication to each other by a transmission cable **11400**.

[0118] The lens unit **11401** is an optical system, provided at a connecting location to the lens barrel **11101**. Observation light taken in from a distal end of the lens barrel **11101** is guided to the camera head **11102** and introduced into the lens unit **11401**. The lens unit **11401** includes a combination of a plurality of lenses including a zoom lens and a focusing lens.

[0119] The number of image pickup elements which is included by the image pickup unit **11402** may be one (single-plate type) or a plural number (multi-plate type). Where the image pickup unit **11402** is configured as that of the multi-plate type, for example, image signals corresponding to respective R, G and B are generated by the image pickup elements, and the image signals may be synthesized to obtain a color image. The image pickup unit **11402** may also be configured so as to have a pair of image pickup elements for acquiring respective image signals for the right eye and the left eye ready for three dimensional (3D) display. If 3D display is performed, then the depth of a living body tissue in a surgical region can be comprehended more accurately by the surgeon **11131**. It is to be noted that, where the image pickup unit **11402** is configured as that of stereoscopic type, a plurality of systems of lens units **11401** are provided corresponding to the individual image pickup elements.

[0120] Further, the image pickup unit **11402** may not necessarily be provided on the camera head **11102**. For example, the image pickup unit **11402** may be provided immediately behind the objective lens in the inside of the lens barrel **11101**.

[0121] The driving unit **11403** includes an actuator and moves the zoom lens and the focusing lens of the lens unit **11401** by a predetermined distance along an optical axis under the control of the camera head controlling unit **11405**. Consequently, the magnification and the focal point of a picked up image by the image pickup unit **11402** can be adjusted suitably.

[0122] The communication unit **11404** includes a communication apparatus for transmitting and receiving various kinds of information to and from the CCU **11201**. The communication unit **11404** transmits an image signal acquired from the image pickup unit **11402** as RAW data to the CCU **11201** through the transmission cable **11400**.

[0123] In addition, the communication unit **11404** receives a control signal for controlling driving of the camera head **11102** from the CCU **11201** and supplies the control signal to the camera head controlling unit **11405**. The control signal includes information relating to image pickup conditions such as, for example, information that a frame rate of a picked up image is designated, information that an exposure value upon image picking up is designated and/or information that a magnification and a focal point of a picked up image are designated.

[0124] It is to be noted that the image pickup conditions such as the frame rate, exposure value, magnification or focal point may be designated by the user or may be set automatically by the control unit **11413** of the CCU **11201** on the basis of an acquired image signal. In the latter case, an auto exposure (AE) function, an auto focus (AF) function and an auto white balance (AWB) function are incorporated in the endoscope **11100**.

[0125] The camera head controlling unit **11405** controls driving of the camera head **11102** on the basis of a control signal from the CCU **11201** received through the communication unit **11404**.

[0126] The communication unit **11411** includes a communication apparatus for transmitting and receiving various kinds of information to and from the camera head **11102**. The communication unit **11411** receives an image signal transmitted thereto from the camera head **11102** through the transmission cable **11400**.

[0127] Further, the communication unit **11411** transmits a control signal for controlling driving of the camera head **11102** to the camera head **11102**. The image signal and the control signal can be transmitted by electrical communication, optical communication or the like.

[0128] The image processing unit **11412** performs various image processes for an image signal in the form of RAW data transmitted thereto from the camera head **11102**.

[0129] The control unit **11413** performs various kinds of control relating to image picking up of a surgical region or the like by the endoscope **11100** and display of a picked up image obtained by image picking up of the surgical region or the like. For example, the control unit **11413** creates a control signal for controlling driving of the camera head **11102**.

[0130] Further, the control unit **11413** controls, on the basis of an image signal for which image processes have been performed by the image processing unit **11412**, the display apparatus **11202** to display a picked up image in which the surgical region or the like is imaged. Thereupon, the control unit **11413** may recognize various objects in the picked up image using various image recognition technologies. For example, the control unit **11413** can recognize a surgical tool such as forceps, a particular living body region, bleeding, mist when the energy device **11112** is used and so forth by detecting the shape, color and so forth of edges of objects included in a picked up image. The control unit **11413** may cause, when it controls the display apparatus **11202** to display a picked up image, various kinds of surgery supporting information to be displayed in an overlapping manner with an image of the surgical region using a result of the recognition. Where surgery supporting information is displayed in an overlapping manner and presented to the surgeon **11131**, the burden on the surgeon **11131** can be reduced and the surgeon **11131** can proceed with the surgery with certainty.

[0131] The transmission cable **11400** which connects the camera head **11102** and the CCU **11201** to each other is an electric signal cable ready for communication of an electric signal, an optical fiber ready for optical communication or a composite cable ready for both of electrical and optical communications.

[0132] Here, while, in the example depicted, communication is performed by wired communication using the transmission cable **11400**, the communication between the camera head **11102** and the CCU **11201** may be performed by wireless communication.

[0133] The description has been given above of one example of the endoscopic surgery system, to which the technology according to an embodiment of the present disclosure is applicable. The technology according to an embodiment of the present disclosure is applicable to, for example, the image pickup unit **11402** of the configurations described above. Applying the technology according to an embodiment of the present disclosure to the image pickup unit **11402** makes it possible to improve detection accuracy.

[0134] It is to be noted that although the endoscopic surgery system has been described as an example here, the technology according to an embodiment of the present disclosure may also be applied to, for example, a microscopic surgery system, and the like.

Application Example 5

<Example of Practical Application to Mobile Body>

[0135] The technology according to an embodiment of the present disclosure (present technology) is applicable to various products. For example, the technology according to an embodiment of the present disclosure may be achieved in the form of an apparatus to be mounted to a mobile body of any kind. Non-limiting examples of the mobile body may include an automobile, an electric vehicle, a hybrid electric vehicle, a motorcycle, a bicycle, any personal mobility device, an airplane, an unmanned aerial vehicle (drone), a vessel, a robot, a construction machine, and an agricultural machine (tractor).

[0136] FIG. **17** is a block diagram depicting an example of schematic configuration of a vehicle control system as an example of a mobile body control system to which the technology according to an embodiment of the present disclosure can be applied.

[0137] The vehicle control system **12000** includes a plurality of electronic control units connected to each other via a communication network **12001**. In the example depicted in FIG. **17**, the vehicle control system **12000** includes a driving system control unit **12010**, a body system control unit **12020**, an outside-vehicle information detecting unit **12030**, an in-vehicle information detecting unit **12040**, and an integrated control unit **12050**. In addition, a microcomputer **12051**, a sound/image output section **12052**, and a vehicle-mounted network interface (I/F) **12053** are illustrated as a functional configuration of the integrated control unit **12050**.

[0138] The driving system control unit **12010** controls the operation of devices related to the driving system of the vehicle in accordance with various kinds of programs. For example, the driving system control unit **12010** functions as a control device for a driving force generating device for generating the driving force of the vehicle, such as an internal combustion engine, a driving motor, or the like, a driving force transmitting mechanism for transmitting the driving force to wheels, a steering mechanism for adjusting the steering angle of the vehicle, a braking device for generating the braking force of the vehicle, and the like.

[0139] The body system control unit **12020** controls the operation of various kinds of devices provided to a vehicle body in accordance with various kinds of programs. For example, the body system control unit **12020** functions as a control device for a keyless entry system, a smart key system, a power window device, or various kinds of lamps such as a headlamp, a backup lamp, a brake lamp, a turn signal, a fog lamp, or the like. In this case, radio waves transmitted from a mobile device as an alternative to a key or signals of various kinds of switches can be input to the body system control unit **12020**. The body system control unit **12020** receives these input radio waves or signals, and controls a door lock device, the power window device, the lamps, or the like of the vehicle.

[0140] The outside-vehicle information detecting unit **12030** detects information about the outside of the vehicle including the vehicle control system **12000**. For example, the outside-vehicle information detecting unit **12030** is connected with an imaging section **12031**. The outside-vehicle information detecting unit **12030** makes the imaging section **12031** image an image of the outside of the vehicle, and receives the imaged image. On the basis of the received image, the outside-vehicle information detecting unit **12030** may perform processing of detecting an object such as a human, a vehicle, an obstacle, a sign, a character on a road surface, or the like, or processing of detecting a distance thereto.

[0141] The imaging section **12031** is an optical sensor that receives light, and which outputs an electric signal corresponding to a received light amount of the light. The imaging section **12031** can output the electric signal as an image, or can output the electric signal as information about a measured distance. In addition, the light received by the imaging section **12031** may be visible light, or may be invisible light such as infrared rays or the like.

[0142] The in-vehicle information detecting unit **12040** detects information about the inside of the vehicle. The in-vehicle information detecting unit **12040** is, for example, connected with a driver state detecting section **12041** that detects the state of a driver. The driver state detecting section **12041**, for example, includes a camera that images the driver. On the basis of detection information input from the driver state detecting section **12041**, the in-vehicle information detecting unit **12040** may calculate a degree of fatigue of the driver or a degree of concentration of the driver, or may determine whether the driver is dozing.

[0143] The microcomputer **12051** can calculate a control target value for the driving force generating device, the steering mechanism, or the braking device on the basis of the information about the inside or outside of the vehicle which information is obtained by the outside-vehicle information detecting unit **12030** or the in-vehicle information detecting unit **12040**, and output a control command to the driving system control unit **12010**. For example, the microcomputer **12051** can perform cooperative control intended to implement functions of an advanced driver assistance system (ADAS) which functions include collision avoidance or shock mitigation for the vehicle, following driving based on a following distance, vehicle speed maintaining driving, a warning of collision of the vehicle, a warning of deviation of the vehicle from a lane, or the like.

[0144] In addition, the microcomputer **12051** can perform cooperative control intended for automatic driving, which makes the vehicle to travel autonomously without depending on the operation of the driver, or the like, by controlling the driving force generating device, the steering mechanism, the braking device, or the like on the basis of the information about the outside or inside of the vehicle which information is obtained by the outside-vehicle information detecting unit **12030** or the in-vehicle information detecting unit **12040**.

[0145] In addition, the microcomputer **12051** can output a control command to the body system control unit **12020** on the basis of the information about the outside of the vehicle which information is obtained by the outside-vehicle information detecting unit **12030**. For example, the microcomputer **12051** can perform cooperative control intended to prevent a glare by controlling the headlamp so as to change from a high beam to a low beam, for example, in accordance with the position of a preceding vehicle or an oncoming vehicle detected by the outside-vehicle information detecting unit **12030**.

[0146] The sound/image output section **12052** transmits an output signal of at least one of a sound and an image to an output device capable of visually or auditorily notifying information to an occupant of the vehicle or the outside of the vehicle. In the example of FIG. **17**, an audio speaker **12061**, a display section **12062**, and an instrument panel **12063** are illustrated as the output device. The display section **12062** may, for example, include at least one of an on-board display and a head-up display.

[0147] FIG. **18** is a diagram depicting an example of the installation position of the imaging section **12031**.

[0148] In FIG. **18**, the imaging section **12031** includes imaging sections **12101**, **12102**, **12103**, **12104**, and **12105**.

[0149] The imaging sections **12101**, **12102**, **12103**, **12104**, and **12105** are, for example, disposed at positions on a front nose, sideview mirrors, a rear bumper, and a back door of the vehicle **12100** as well as a position on an upper portion of a windshield within the interior of the vehicle. The imaging section **12101** provided to the front nose and the imaging section **12105** provided to the upper portion of the windshield within the interior of the vehicle obtain mainly an image of the front of the vehicle **12100**. The imaging sections **12102** and **12103** provided to the sideview mirrors obtain mainly an image of the sides of the vehicle **12100**. The imaging section **12104** provided to the rear bumper or the back door obtains mainly an image of the rear of the vehicle **12100**. The imaging section **12105** provided to the upper portion of the windshield within the interior of the vehicle is used mainly to detect a preceding vehicle, a pedestrian, an obstacle, a signal, a traffic sign, a lane, or the like.

[0150] Incidentally, FIG. **18** depicts an example of photographing ranges of the imaging sections **12101** to **12104**. An imaging range **12111** represents the imaging range of the imaging section **12101** provided to the front nose. Imaging ranges **12112** and **12113** respectively represent the imaging ranges of the imaging sections **12102** and **12103** provided to the sideview mirrors. An imaging range **12114** represents the imaging range of the imaging section **12104** provided to the rear bumper or the back door. A bird's-eye image of the vehicle **12100** as viewed from above is obtained by superimposing image data imaged by the imaging sections **12101** to **12104**, for example.

[0151] At least one of the imaging sections **12101** to **12104** may have a function of obtaining distance information. For example, at least one of the imaging sections **12101** to **12104** may be a stereo camera constituted of a plurality of imaging elements, or may be an imaging element having pixels for phase difference detection.

[0152] For example, the microcomputer **12051** can determine a distance to each three-dimensional object within the imaging ranges **12111** to **12114** and a temporal change in the distance (relative speed with respect to the vehicle **12100**) on the basis of the distance information obtained from the imaging sections **12101** to **12104**, and thereby extract, as a preceding vehicle, a nearest three-dimensional object in particular that is present on a traveling path of the vehicle **12100** and which travels in substantially the same direction as the vehicle **12100** at a predetermined speed (for example, equal to or more than **0** km/hour). Further, the microcomputer **12051** can set a following distance to be maintained in front of a preceding vehicle in advance, and perform automatic brake control (including following stop control), automatic acceleration control (including following start control), or the like. It is thus possible to perform cooperative control intended for automatic driving that makes the vehicle travel autonomously without depending on the operation of the driver or the like.

[0153] For example, the microcomputer **12051** can classify three-dimensional object data on three-dimensional objects into three-dimensional object data of a two-wheeled vehicle, a standard-sized vehicle, a large-sized vehicle, a pedestrian, a utility pole, and other three-dimensional objects on the basis of the distance information obtained from the imaging sections **12101** to **12104**, extract the classified three-dimensional object data, and use the extracted three-dimensional object data for automatic avoidance of an obstacle. For example, the microcomputer **12051** identifies obstacles around the vehicle **12100** as obstacles that the driver of the vehicle **12100** can recognize visually and obstacles that are difficult for the driver of the vehicle **12100** to recognize visually. Then, the microcomputer **12051** determines a collision risk indicating a risk of collision with each obstacle. In a situation in which the collision risk is equal to or higher than a set value and there is thus a possibility of collision, the microcomputer **12051** outputs a warning to the driver via the audio speaker **12061** or the display section **12062**, and performs forced deceleration or avoidance steering via the driving system control unit **12010**. The microcomputer **12051** can thereby assist in driving to avoid collision.

[0154] At least one of the imaging sections **12101** to **12104** may be an infrared camera that detects infrared rays. The microcomputer **12051** can, for example, recognize a pedestrian by determining whether or not there is a pedestrian in imaged images of the imaging sections **12101** to **12104**. Such recognition of a pedestrian is, for example, performed by a procedure of extracting characteristic points in the imaged images of the imaging sections **12101** to **12104** as infrared cameras and a procedure of determining whether or not it is the pedestrian by performing pattern matching processing on a series of characteristic points representing the contour of the object. When the microcomputer **12051** determines that there is a pedestrian in the imaged images of the imaging sections **12101** to **12104**, and thus recognizes the pedestrian, the sound/image output section **12052** controls the display section **12062** so that a square contour line for emphasis is displayed so as to be superimposed on the recognized pedestrian. The sound/image output section **12052** may also control the display section **12062** so that an icon or the like representing the pedestrian is displayed at a desired position.

[0155] Although the description has been given hereinabove referring to the embodiment and the modification examples, the content of the present disclosure is not limited to the foregoing embodiment, etc. and may be modified in a wide variety of ways.

[0156] It is to be noted that the effects described herein are merely exemplary and not limitative, and may include other effects.

[0157] It is to be noted that the present disclosure may also have the following configurations.

(1)

[0158] An imaging element including:

[0159] a sensor substrate having a light-receiving region in which a plurality of light-receiving elements are arranged and a peripheral region provided around the light-receiving region;

[0160] a sealing member disposed to be opposed to one surface of the sensor substrate;

[0161] a resin layer that attaches the sensor substrate and the sealing member to each other; and

[0162] an excavated part provided in the peripheral region of the one surface of the sensor substrate, and in which the resin layer is embedded,

[0163] the resin layer having one or a plurality of gaps inside the excavated part in a plan view.

(2)

[0164] The imaging element according to (1), in which the resin layer has a nanobubble structure as the gaps.

(3)

[0165] The imaging element according to (1), in which the resin layer has a microbubble structure as the gaps.

(4)

[0166] The imaging element according to any one of (1) to (3), in which the gaps are provided in at least one of an inside of the excavated part or a region above the excavated part.

(5)

[0167] The imaging element according to any one of (1) to (4), in which the sealing member has light-transmissivity.

(6)

[0168] The imaging element according to any one of (1) to (5), in which the resin layer is formed using at least one of an acrylic-based resin material, a styrene-based resin material, or an epoxy resin material.

(7)

[0169] The imaging element according to any one of (1) to (6), in which the sensor substrate has another surface opposed to the one surface and includes a multilayer wiring layer on the other surface.

(8)

[0170] An electronic apparatus including an imaging element,

[0171] the imaging element including

[0172] a sensor substrate having a light-receiving region in which a plurality of light-receiving elements are arranged and a peripheral region provided around the light-receiving region,

[0173] a sealing member disposed to be opposed to one surface of the sensor substrate,

[0174] a resin layer that attaches the sensor substrate and the sealing member to each other, and

[0175] an excavated part provided in the peripheral region of the one surface of the sensor substrate, and in which the resin layer is embedded,

[0176] the resin layer having one or a plurality of gaps inside the excavated part in a plan view.

[0177] This application claims the benefit of Japanese Priority Patent Application JP2018-136049 filed with the Japan Patent Office on Jul. 19, 2018, the entire contents of which are incorporated herein by reference.

[0178] It should be understood by those skilled in the art that various modifications, combinations, sub-combinations, and alterations may occur depending on design requirements and other factors insofar as they are within the scope of the appended claims or the equivalents thereof.

1. An imaging element comprising:

a sensor substrate having a light-receiving region in which a plurality of light-receiving elements are arranged and a peripheral region provided around the light-receiving region;

a sealing member disposed to be opposed to one surface of the sensor substrate;

a resin layer that attaches the sensor substrate and the sealing member to each other; and

an excavated part provided in the peripheral region of the one surface of the sensor substrate, and in which the resin layer is embedded,

the resin layer having one or a plurality of gaps inside the excavated part in a plan view.

2. The imaging element according to claim **1**, wherein the resin layer has a nanobubble structure as the gaps.

3. The imaging element according to claim **1**, wherein the resin layer has a microbubble structure as the gaps.

4. The imaging element according to claim **1**, wherein the gaps are provided in at least one of an inside of the excavated part or a region above the excavated part.

5. The imaging element according to claim **1**, wherein the sealing member has light-transmissivity.

6. The imaging element according to claim **1**, wherein the resin layer is formed using at least one of an acrylic-based resin material, a styrene-based resin material, or an epoxy resin material.

7. The imaging element according to claim **1**, wherein the sensor substrate has another surface opposed to the one surface and includes a multilayer wiring layer on the other surface.

8. An electronic apparatus comprising an imaging element,

the imaging element including

a sensor substrate having a light-receiving region in which a plurality of light-receiving elements are arranged and a peripheral region provided around the light-receiving region,

a sealing member disposed to be opposed to one surface of the sensor substrate,

a resin layer that attaches the sensor substrate and the sealing member to each other, and

an excavated part provided in the peripheral region of the one surface of the sensor substrate, and in which the resin layer is embedded,

the resin layer having one or a plurality of gaps inside the excavated part in a plan view.

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